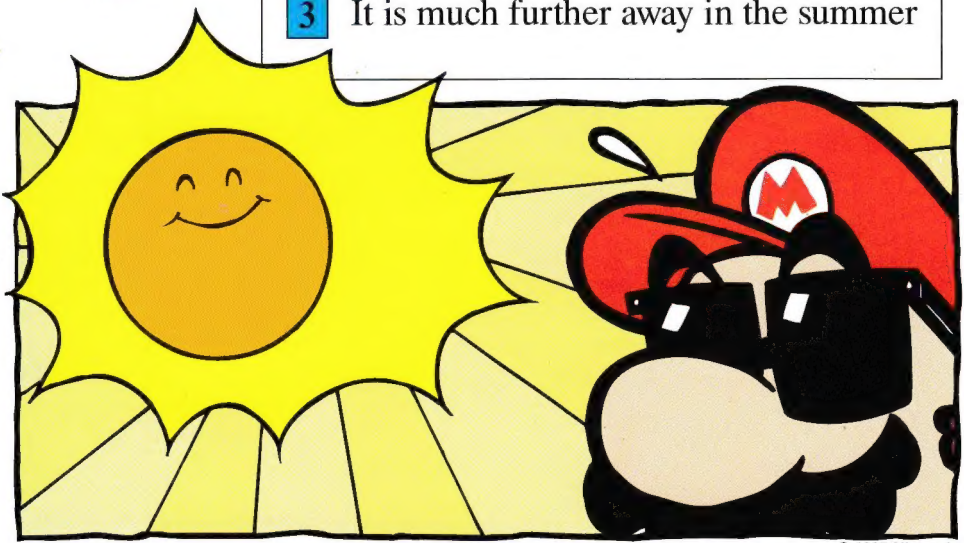
Is the Earth closer to the sun in the summer?

THE UNIVERSE

1. It is closer in the summer than in the winter
2. It is the same distance all the year
3. It is much further away in the summer



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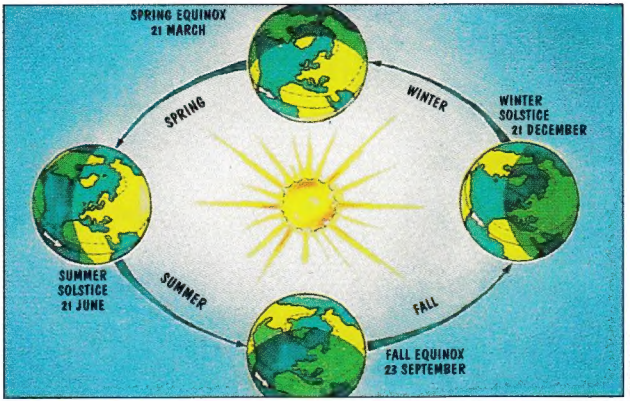
Earth

All year, Earth is about the same distance from the sun: about 93 million miles (150 million km).

2 Earth is more or less the same distance from the sun all year.



Ill. Y. Tabarlés

Earth makes an elliptical orbit around the sun. The journey takes one year–four seasons. Summer is hot because the sun stays above the horizon longer.

If Earth is the same distance from the sun all year long, then why is it cold in winter and hot in summer? It's due to the fact that Earth "leans" on its axis as it orbits around the sun. The axis, an imaginary line connecting the North Pole and the South Pole, isn't vertical–straight up and down. It always tilts as we move through space.

Playing Angles

As Earth orbits around the sun, the angles of the sun's rays are different in each hemisphere. So there's a difference in the amount of heat received from the sun. In the summer, the North Pole is angled toward the sun. So in the Northern hemisphere, the sun's trip from sunrise to sunset takes longer. Meanwhile, people in the southern hemisphere have winter because they're angled away from the sun.

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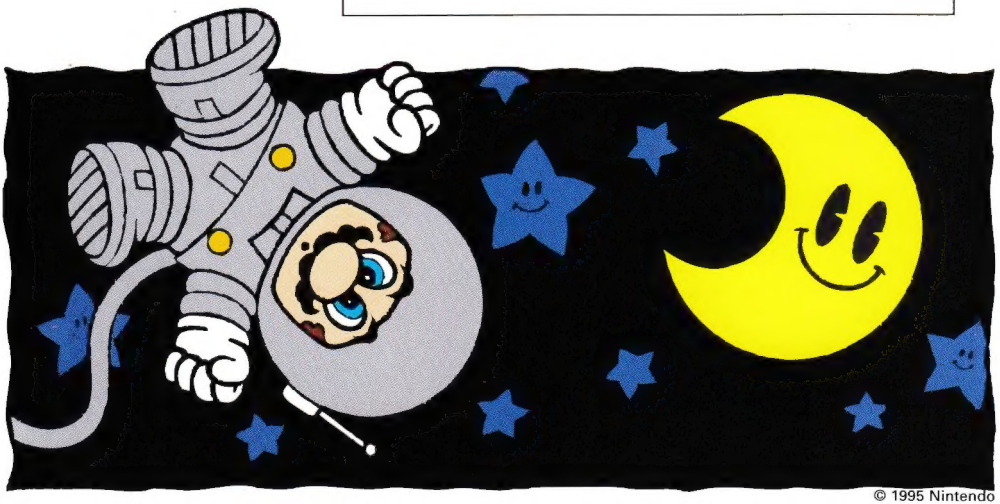
Who were the first men to walk on the moon?

THE UNIVERSE

1. The Russian: Gagarin
2. The Frenchman: Chrétien
3. The Americans: Armstrong and Aldrin



© 1995 Nintendo

Moon

On July 20, 1969, Americans Neil Armstrong and Edwin Aldrin set foot on the moon.

3 Americans Neil Armstrong and Edwin Aldrin were the first humans to walk on the moon.

As the first humans stepped onto the moon at 3:00 a.m., millions of people around the world watched on TV.

The Apollo XI space vehicle, piloted by Armstrong, Aldrin, and Michael Collins, blasted off from Earth on July 16th. On the 19th, it went into orbit around the moon. The next day, Armstrong and Aldrin left the spacecraft in the lunar landing module. They began their descent, landing without a hitch in the Sea of Tranquility. Armstrong opened the hatch and his first words on setting foot on the moon were the famous "that's one small step for a man, one giant leap for mankind!" The two astronauts brought back over 45 lb (about 21 kg) of moon samples and deployed a number of scientific instruments.

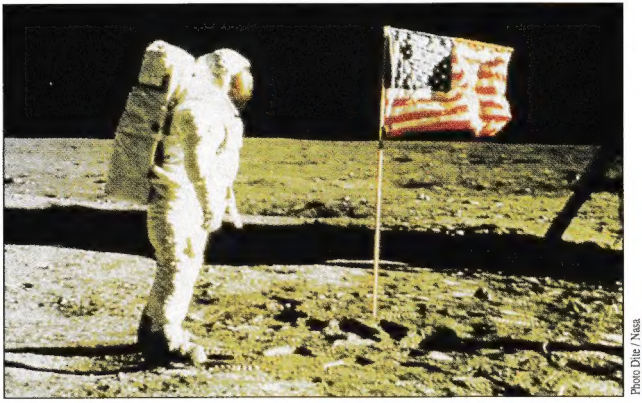


Photo Dite / Nasa

As well as the U.S. flag, the astronauts left behind a commemorative steel plaque that read: "We came in peace for all mankind."

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D3 054 02-14

Why do we have day and night?

THE UNIVERSE

1. Earth revolves around the sun
2. Earth rotates on its own axis
3. The moon reflects the light from the rotating sun

©1995 Nintendo

Day and Night

Like a revolving door spinning on its center pole, Earth turns on it's axis—an imaginary line through the planet. As Earth turns, one half of it turns toward the sun; the other half faces away from the sun.

2 We have day and night because Earth rotates on its own axis.

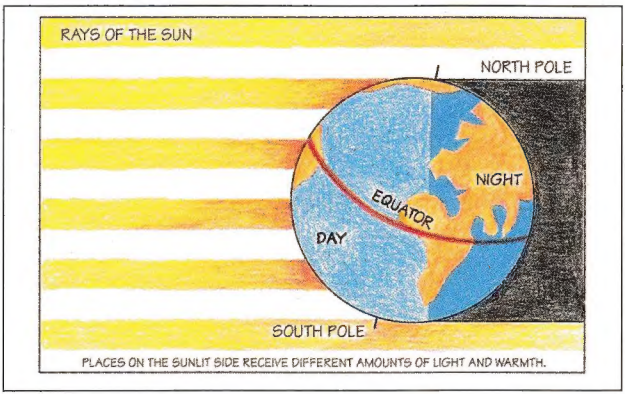

Illustration by Mimi Perrotti

Earth makes one complete turn on its axis every 24 hours, creating day and night.

Constant sunlight

The sun never stops shining, but it lights only the half of Earth that's facing it. That half has day. The half turned away from the sun has night. If Earth were motionless, one half would always have day and the other would always have night. But Earth makes one complete revolution on its axis each 24 hours. So each half has day and night, depending on whether it's facing or turned away from the sun.

Trail of Sunlight

People say the sun "rises in the east" each morning and "sets in the west" each night. You know that's not really true, because the sun doesn't move...Earth does! But as our planet rotates from west to east on its axis, the sun does appear to move from east to west across the sky. Check it out!

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Why does the moon change shape?

THE UNIVERSE

1. It rotates on its axis
2. Another planet regularly hides part of the moon
3. We see it in different positions relative to the sun

©1995 Nintendo

Moon

The moon travels around Earth just as Earth travels around the sun. Because of these movements in space, we see the moon differently at different times.

3 The moon changes shape because we see it in different positions relative to the sun.

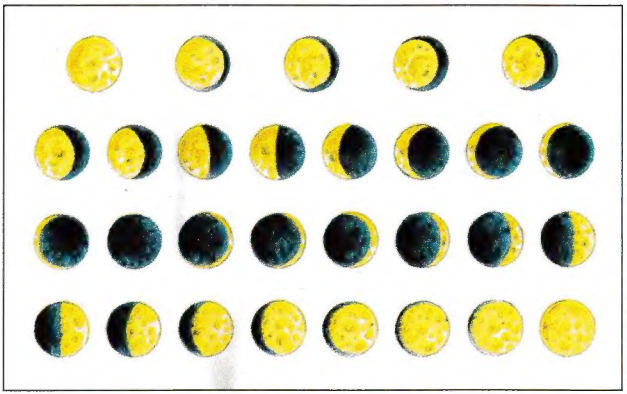

Illustration by J. Dang

When the moon is between the sun and Earth, it's invisible to Earth. This monthly cycle of moon phases covers a period of 29 days.

Sunlight, Moonglow

If the Moon could shine by itself, we'd always see it as a round, bright object in the sky. But the moon has no light of its own, it simply reflects light from the sun. And at different times, different amounts of the sun's light reach the moon.

Moon Phases

When the moon gets between the sun and Earth, no light from the sun can reach the side of the moon facing Earth. This moon without light is called the new moon. Next we see a crescent-shaped moon., after which the "slices" of moon get bigger and bigger. When the sun and moon are positioned in opposite directions, we see a full moon—the side of moon that faces Earth is completely lit. Finally, little by little, the section of moon that's lighted gets smaller and smaller, and the whole cycle starts over again.

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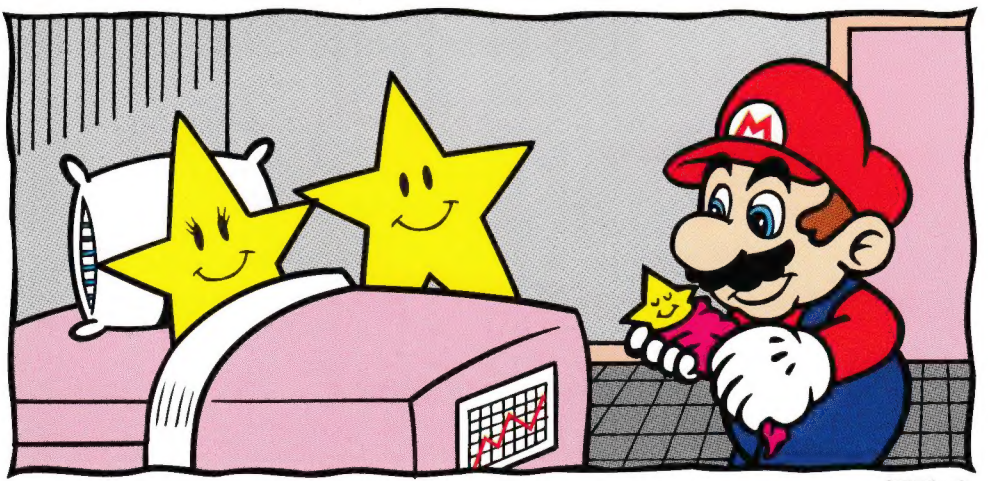
How is a star born?

THE UNIVERSE

1. From a cloud of fine dust and gas
2. From a decayed planet
3. From particles of the sun



©1995 Nintendo

Star

A new star begins as a cloud of gas and dust. Then the cloud contracts, becomes overheated, and shines!

1 A star is born from a cloud of fine dust and gas.

Photo © Science Source / Explorer

Astronomers, thanks to strong telescopes, can study hundreds of millions of stars that are born and die in our universe.

A star is a hot, glowing body in space, varying in size and brightness. The sun is a star, It may appear to be a really big star, but that's because it's closer to Earth.

Star Struck

The atmosphere is full of different gases and fine dust particles. If enough hydrogen gas collects at some point in space, instead of drifting around, its molecules can be held together with dust and form a gas cloud. If the cloud is a great enough mass, the gas will contract under its own weight and pressure. The more the mass contracts, the more the trapped gas overheats, the center of the mass then ignites, and a new "star" begins to shine.

Spheres of Gas

Stars create light by transforming their main gas, hydrogen, into another, helium. This conversion emits heat and light from the star for billions of years. When a star finally uses up all its hydrogen, it expands, explodes, collapses, and its light goes out forever.

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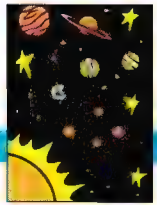
What's a solar eclipse?



THE UNIVERSE

1. The temporary disappearance of a star
2. A solar eruption
3. A momentary reduction in solar energy

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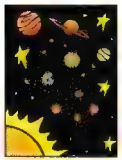
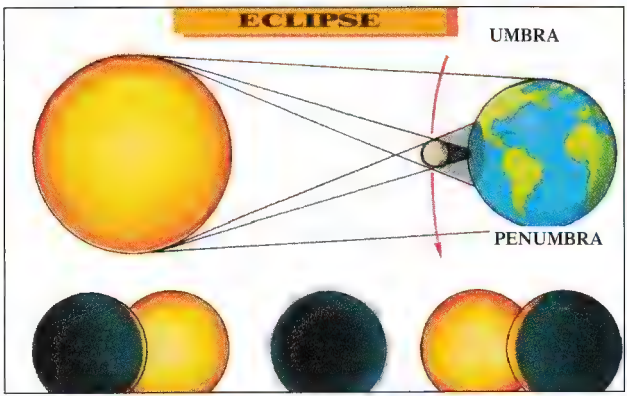
Eclipse

An observer on Earth can witnesses a solar eclipse when the moon passes in front of the sun and hides it. Since the sun is a star, the solar eclipse has made a star disappear!

1 A solar eclipse is the temporary disappearance of a star.





© Bova / Science Source / Explorer

A partial eclipse. The phenomenon of the sun's disappearance is only relative since it's hidden only to observers located at a specific site on Earth.

Seen from Earth, the sun and moon appear to be approximately the same diameter. In reality, the sun is much larger than our moon, but it's farther away. Because the two objects do appear the same size, we can observe the phenomenon of an eclipse.

Brief Disappearance

It's nice to know that when the sun "disappears," it won't be for long. The maximum length of a total eclipse is 7 minutes at the Equator and 6 minutes at 45 degrees latitude, like Bangor, Maine. Also, an eclipse isn't visible to everyone, but is limited to just one portion of Earth's surface. Usually the path of view in no wider than 167 miles (268 km). There's at least one solar eclipse each year, and each year it's visible in a different place on Earth. Total eclipses are rare. There may be only one visible from a given spot every 360 years!

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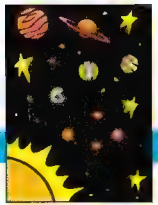
How old is Earth?



THE UNIVERSE

1. 500 million years
2. 4.5 billion years
3. 20 billion years

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Earth

How can you find out how old Earth is? Scientists discovered that by carbon-dating old rocks from Earth's surface they would know. Their answer? Earth is 4.5 billion years old.

2 Earth is approximately 4.5 billion years old.

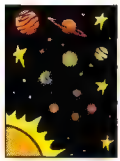

Photo © Krafft / Explorer

In order to calculate Earth's age, scientists have to first find and calculate the ages of the most ancient rocks known on the planet.

Radioactivity

Researchers were able to figure out the age of rocks from Earth's surface thanks to the discovery of how long it takes for radioactive elements to leave an object. Scientists discovered that things lose their radioactivity at a specific rate of speed. So first the experts measure the amount of radioactivity lost from a sample rock. Then, through some complicated calculations, the scientists can determine how long it took the rock to lose the radioactive elements. Finally, that figure will tell how old the rock is, so it tells how old Earth is too. After all, Earth had to be here at least as long as the rock was…or longer!

Happy Birthday, Earth

By comparing metal from ocean depths and metal from meteorites, a scientist named Patterson calculated Earth's age in 1956. He calculated its age to be 4.5 billion years.

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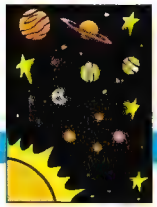
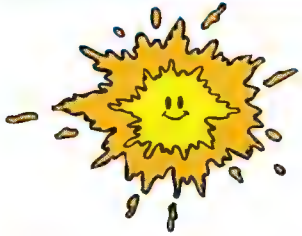
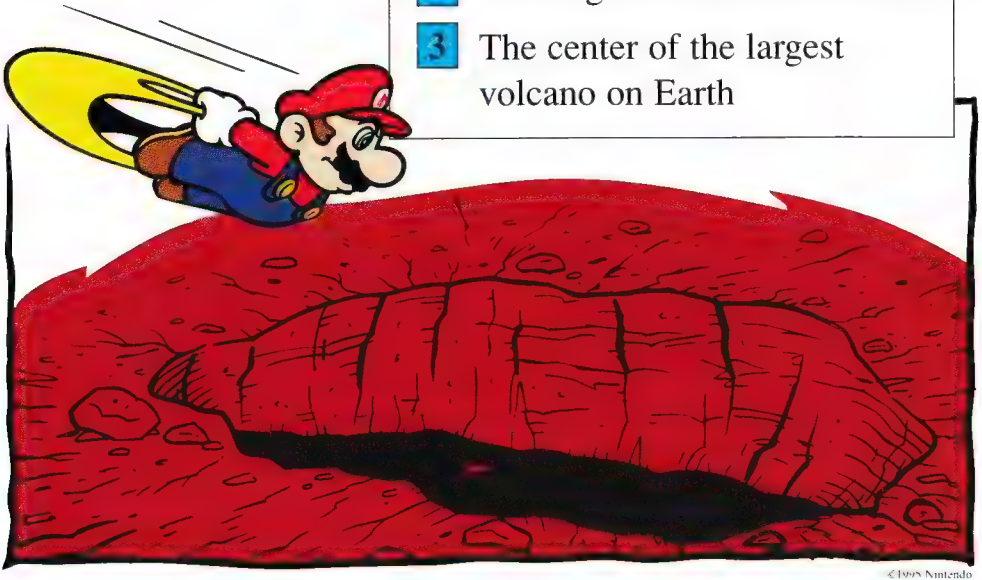
What is Meteor Crater?



THE UNIVERSE



1. The largest hole made by a meteor on Earth's surface
2. The largest crater on the moon
3. The center of the largest volcano on Earth



©1993 Nintendo

Meteor Crater

Some 50,000 years ago, a giant meteoric mass slammed into Earth's surface. It left a hole 4,150 ft (1,265 m) across and 570 ft (174 m) deep, whose rim rises another 150 ft (46 m) above the Arizona countryside.

1 **Meteor Crater is the largest hole known to have been made in Earth's surface by a meteor.**

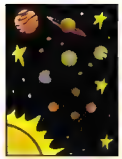


Illustration by Y. Tabaries

It's uncommon for very large meteorites, like the one that landed in Arizona, to reach Earth. Most break into smaller pieces in space before they fall to Earth.

In 1891, a gigantic hole was discovered in the Painted Desert about 40 miles (64 km) southeast of Flagstaff, Arizona. But it wasn't until 1960, after scientists found numerous fragments of iron and nickel—the basic elements in meteorites—in the area, that the scientists realized that a giant meteorite fell to Earth, shattering on impact and creating the enormous crater. To produce a hole this size, scientists believe the meteorite was traveling 33,000 miles (53,097 km) per hour.

Rocky Explosion

When the gigantic meteorite smashed into Earth and exploded, its force was 25 times greater than that of an atomic bomb. It splattered 500,000,000 tons (607,202,000 metric tons) of rock from Earth's surface and destroyed all life within 100 miles (161 km) of the point of impact!

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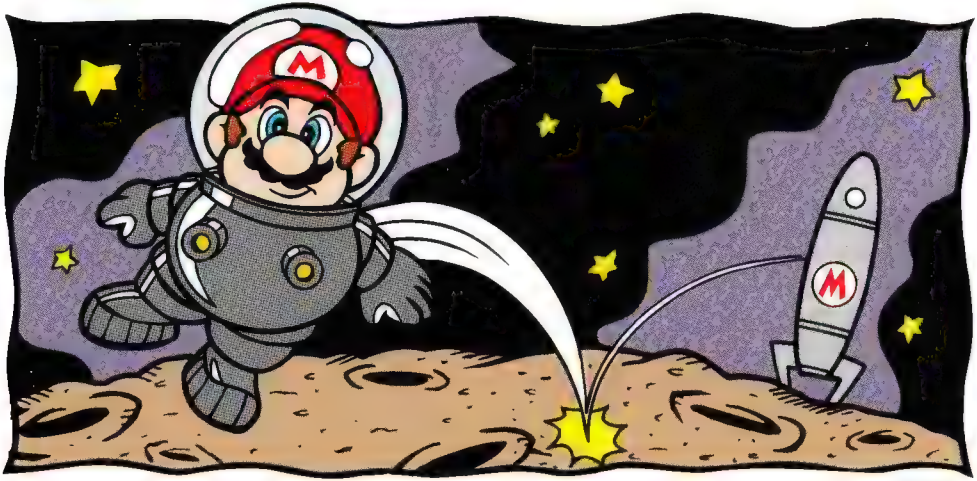
Why do astronauts "weigh" less on the moon?

THE UNIVERSE

1. Because they eat less
2. Because they're not affected by gravity
3. Because the lunar winds lift them



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Weightlessness

Astronauts look light as a feather leaping across the moon's surface. That's because they're not influenced as much by gravity that holds them down on Earth!

2 Astronauts "weigh" less on the moon because they're not affected by gravity.

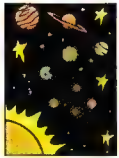

Photo © Bauer/NASA/Explorer

Without the pull of Earth's gravity to hold him down, this astronaut floats weightlessly as he works in space.

To understand weightlessness, you need to know the difference between weight and mass. Gravity pulls everything toward the center of Earth. Weight is the force with which Earth pulls the body: mass is the amount of stuff in the body. If gravity changes, mass doesn't, but weight does.

Far from Earth

When astronauts leave Earth, their mass doesn't change. But their weight does because gravity's pull is very small so far from Earth. They float around as if there were no gravity. But remember, gravity is always there, it just doesn't have the same effect. The moon is smaller than Earth and pulls the body with six times less force. So someone who weighs 132 pounds (60 kg) on Earth weighs 26 pounds (10 kg) on the moon.

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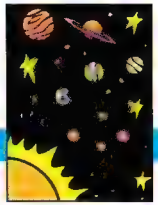
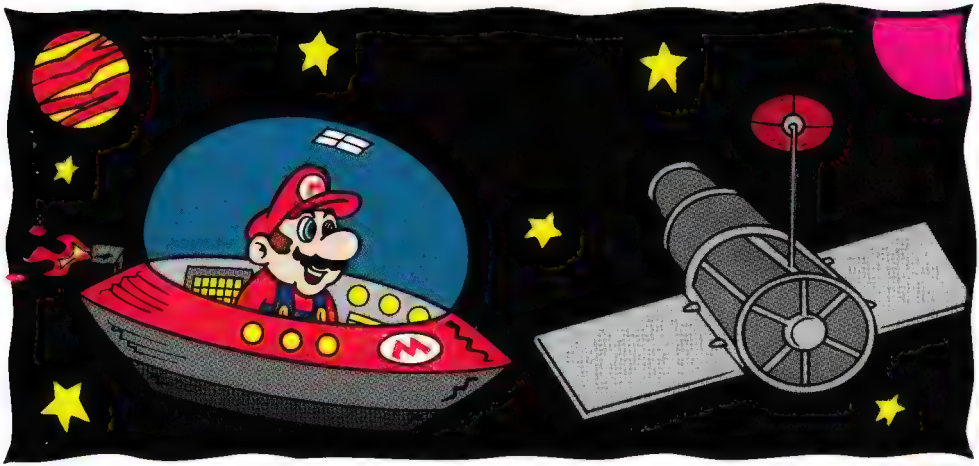
Why don't artificial satellites fall from space?



THE UNIVERSE

1. Their orbiting speeds cancel out the effects of Earth's gravitational pull
2. They float freely on solar winds



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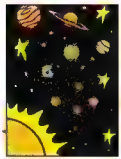
Artificial Satellites

Each artificial satellite is programmed to move at a particular speed. Onboard computers monitor speed and position, and can be remotely controlled by technicians on Earth if necessary.

1 An artificial satellite is kept from falling from space by its traveling speed.



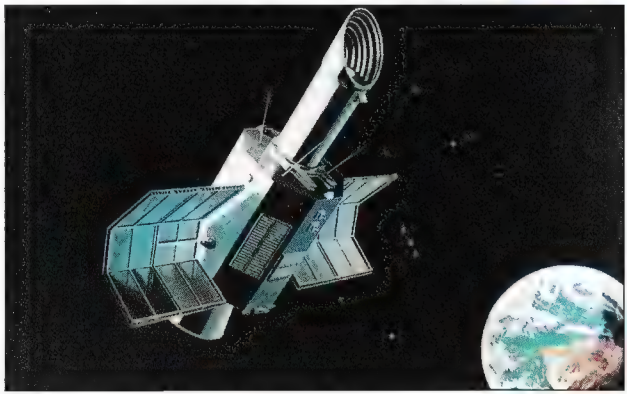


Illustration © Bauer / Explorer

An artificial satellite in orbit around Earth.

An artificial satellite uses its power supply—solar panels, batteries, or fuel cells—and rockets to maintain and correct its speed and position.

Orbits

Objects are kept in orbit by a combination of Earth's gravity and the object's speed. Between any two masses, like Earth and the sun, is a force of mutual attraction. So if Earth didn't revolve quickly around the sun, it would be pulled into it.

You can experiment with this concept. Tie a weight on the end of a string. The weight represents Earth; the string represents the sun's pull on Earth; and your hand represents the sun. Spin the weight slowly around your head, then gradually faster and faster. As the speed increases, the weight exerts more "pull" on the string and your hand. So the speed of your "Earth" (the weight) keeps it a safe distance from the heat of the "sun" (your hand).

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What's a constellation?

THE UNIVERSE

1. A group of stars
2. A gathering of interstellar dust
3. A group of planets

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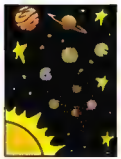
Constellation

Ancient astronomers divided the sky into 88 areas or constellations. All stars within a given area of the sky belong to that constellation.

1 A constellation is a group of stars.



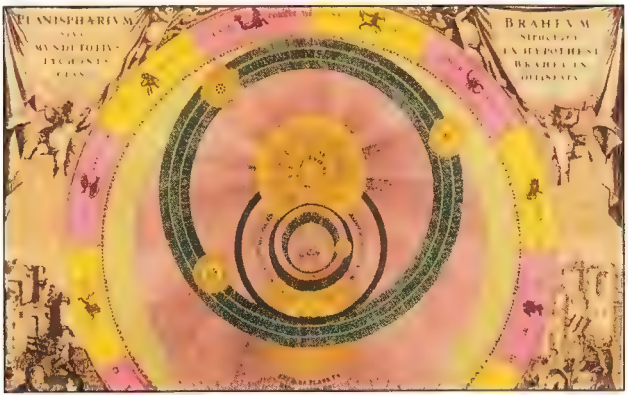


Photo © Explorer Archives

Ancient maps plot the constellations as they move through space.

Astronomers divided the sky to establish convenient points for navigation. The Greeks and Romans thought the star groups formed shapes, and named them for animals and characters in myths: Leo (lion), Taurus (bull), Orion, Andromeda, and Cassiopeia. Later, sailors in the southern hemisphere saw and named other constellations: Telescopium (telescope), Musca (fly), Tucana (toucan).

Moving Stars

Stars appear fixed to us because we're so far away from them. But stars within a constellation move very slowly in relation to one another. They move so slowly you'd never notice it in a lifetime. But astronomer Edmond Halley noticed the shifting stars in 1718. He saw that some were in slightly different positions from those on a sky map drawn by Ptolemy sixteen centuries earlier.

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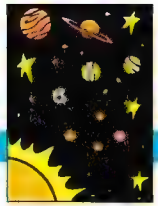
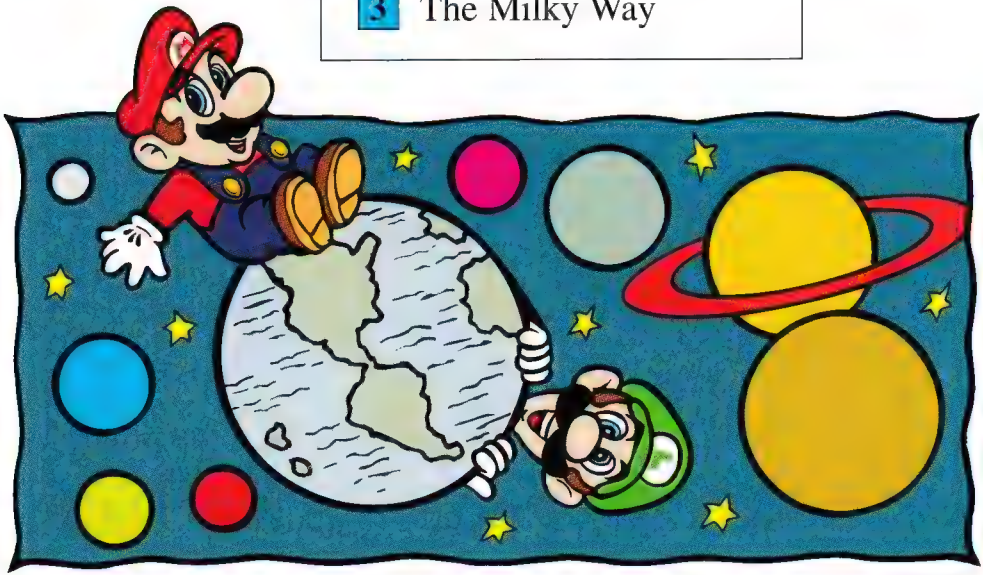
To which galaxy does Earth belong?



THE UNIVERSE

1. The Andromeda Strain
2. The Sea of Magellan
3. The Milky Way



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Milky Way

Our solar system isn't isolated in the universe. It belongs to a group of about 100 billion stars called a galaxy.

3 Earth is a part of the Milky Way Galaxy.

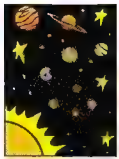

Photo © Sipa Press

Earth sits about 25,000 light-years away from the center of the Milky Way, just one of countless galaxies that populate the universe.

Our galaxy, the Milky Way, is a broad, milky-looking band of stars stretching across the sky like a thin disk with a bulging center. Stars, dust, and gas extend from the center in long curving arms to form a coiling (spiral) pattern. From above, the galaxy looks like a giant pinwheel. But from our point of view, through telescopes, we see only the horizon; the bulge, and the disk surrounded by the halo—old stars clustered in a dense ball-like group.

How Far?

The Milky Way is 100,000 light-years wide and about 10,000 light-years thick at the bulge. That's hard to imagine because the distance light travels in 1 year is about 5.88 trillion miles (9.46 trillion km).

Galaxy Go-Round

Our galaxy rotates nonstop, carrying its stars and planets on an irregular trip through the universe. It takes 250 billion years to make one full rotation!

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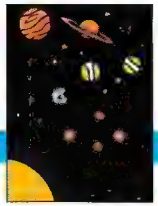
How do astronomers calculate the distances of stars?



THE UNIVERSE

1. In solar years
2. In lunar years
3. In light years

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Measuring Stars

Distances between objects in the solar system are measured in light years. A light year is the distance that light travels in one year—5.88 trillion miles (9.46 trillion km).

3 Astronomers calculate the distances of stars in light years.

Photo © Science Source / Explorer

Stars move in space, but very slowly. Special photography like this catches the tiniest movement of the colorful stars in space.

In their attempts to understand our vast universe, astronomers study the brightness and color of each star. The brightness indicates a star's size; the color of a star indicates its surface temperature.

Magnitude

Magnitude is the measure of a star's brightness. The brighter the star, the lower its magnitude—some are less than zero. So a -0.71 magnitude star is brighter than a +1. Sirius, sometimes known as the Dog Star, is the brightest star of all. It's magnitude is -1.47.

Color

Starlight is a combination of colors. Cool stars give off more red light than blue. Red stars, like Betelgeuse, register about 5,000° F (2,800° C). Really hot stars give off more blue light than red. Blue stars, like Rigel, measure around 50,000° F (28,000° C). Yellow stars, such as our sun, fall in between red and blue. The sun's temperature is 10,000° F (5,500° C).

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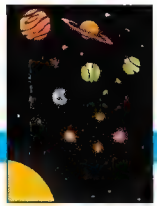
What are the dark spots on the moon?



THE UNIVERSE

1 Islands
2 Plains
3 Seas

©1995 Nintendo

Dark Spots on the Moon

Observed with the naked eye, the surface of the moon appears to have large dark spots that look like basins of water or seas. These are the rocky lunar plains.

2 The dark spots on the moon are vast plains.

Photo © J. Bova / Explorer

Most of the moon is invisible from Earth. The far side, known as the dark side, can't reflect the sun's light toward us.

The moon's plains are called seas because ancient astronomers thought they were large bodies of water. So they gave them names such as Sea of Tranquillity, Sea of Serenity, Ocean of Storms, Sea of Vapors, and Sea of Showers. They named 28 different "seas" on the moon's surface. Today we know there's no water on the moon, but the seas retain their original names.

Lunar Landscape

Besides plains, the lunar surface is covered with craters, canyons, channels, valleys, and freestanding rock pillars. They were created by giant meteorites that bombarded the moon's surface billions of years ago, scarring the crust and blasting out huge great basins. About 3 billion years ago, lava from the moon's interior filled the basins and solidified, creating what we see today as the dark spots on the moon.

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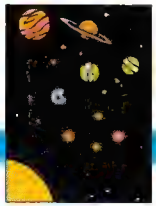
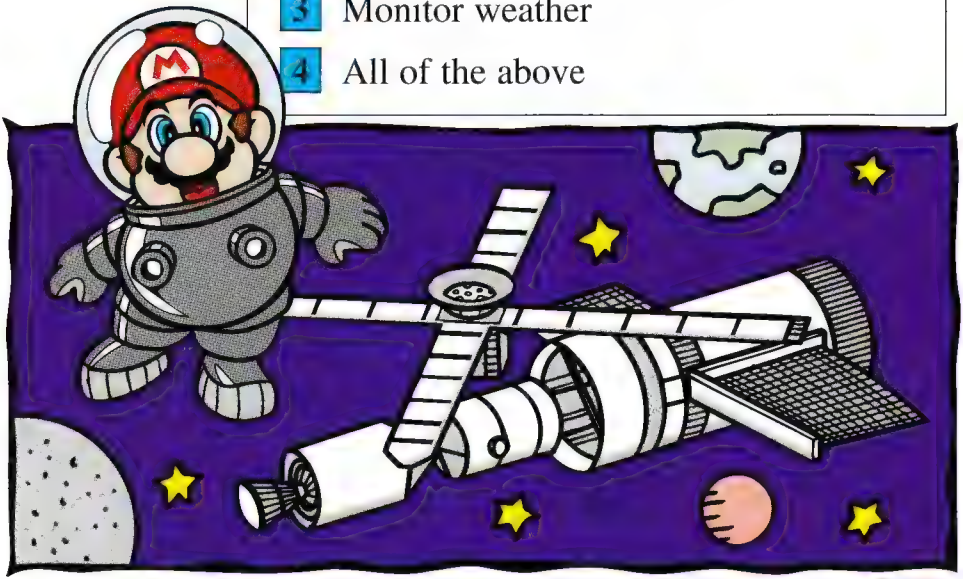
Which task can satellites perform?



THE UNIVERSE

1. Transmit radio and TV signals to Earth
2. Gather data for mapmaking
3. Monitor weather
4. All of the above



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Satellite Assignments

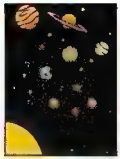
Artificial satellites are used for scientific and military purposes, communications, navigation, and weather forecasting. Russia launched the first artificial satellite, Sputnik I, in 1957.

Artificial satellites are manmade objects placed in orbit. There are more than 70,000 satellites orbiting Earth right now, including operating satellites and space junk, like satellites that no longer work or ejected parts of rockets. Operating satellites are used in many ways.

Sending Signals

Satellites are used to gather data and relay it to Earth.

4 Satellites can perform all of the tasks listed...and more.



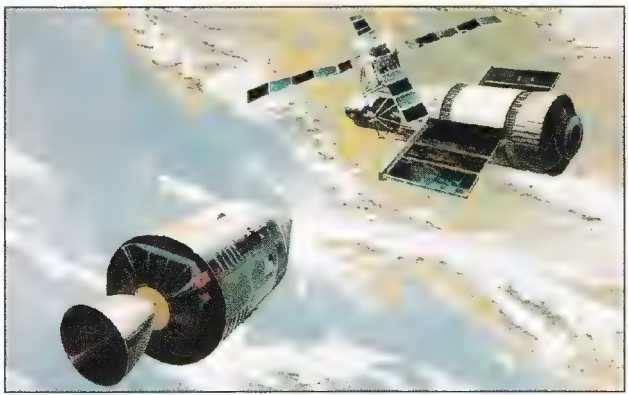


Photo © B. Bauer, Explorer

Many artificial satellites have solar panels to supply the energy to run on-board computers and data-gathering equipment.

For example, many sky observations, like measuring star distances, are best made above the disturbances of Earth's atmosphere. Satellites have a clear view to collect facts and transmit them by radio or TV waves to scientists on Earth. Satellites are also used to bounce back signals sent from Earth. For example, TV signals from Earth are bounced back to a satellite dish. There are devices that can pick up and read specific satellite signals to determine exact geographical locations on Earth.

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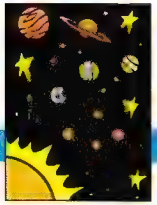
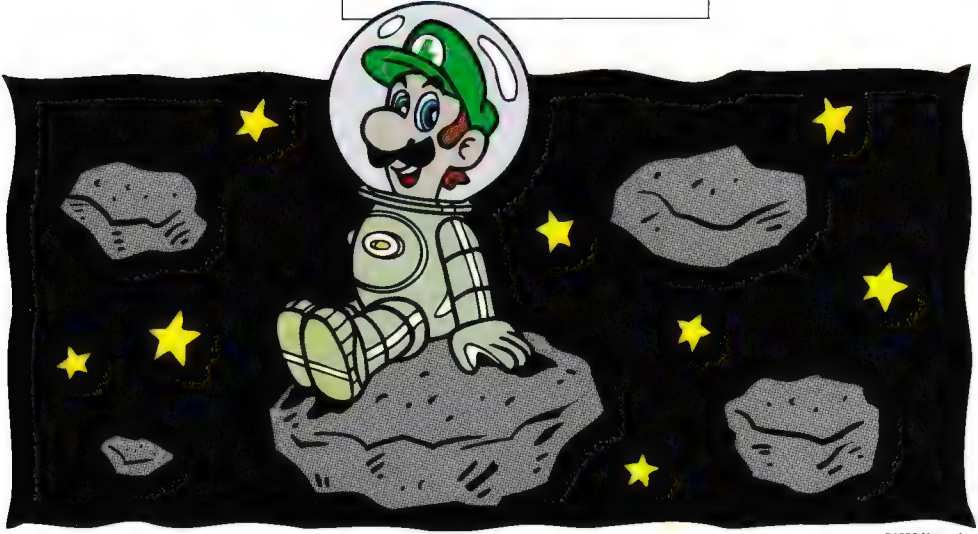
What are asteroids?



THE UNIVERSE

1. Falling stars
2. Mini planets
3. Constellations



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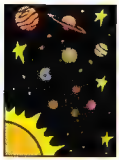
Asteroids

Asteroids, also called minor planets or planetoids, are extremely small planets revolving around the sun. There are thousands of known asteroids, and new ones are constantly found.

2 Asteroids are mini planets.



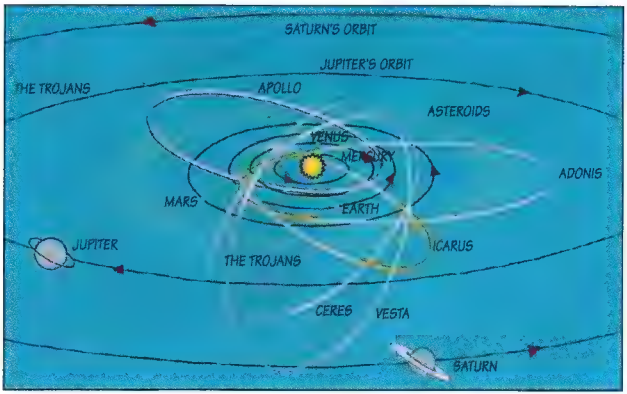


Illustration © Y. Tabarié's

Asteroids are difficult to study in detail from Earth, so scientists study photos of the minor planets taken by NASA space probes.

Asteroids come in a wide variety of sizes and shapes. The largest, Ceres, has a diameter of 600 miles (966 km). It was the first asteroid to be discovered—by Giuseppi Piazzi in 1801.

Asteroids in Orbit

Most of the asteroids travel between the orbits of Mars and Jupiter. Scientists know the orbits of 4,000 asteroids well enough to predict their locations. Some small asteroids have elongated orbits, like that of Earth, and on occasion, they've traveled close to Earth. The closest was the asteroid Hermes which came within 485,000 miles (780,500 km) in 1937. Asteroid orbits change due to gravitational attraction of planets. Over time this could lead to collisions. Fragments would fall to Earth as meteorites. Many scientists believe that 65 million years ago a meteorite caused the extinction of dinosaurs.

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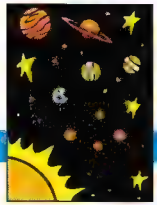
Which planet is second from the sun?



THE UNIVERSE

1. Neptune
2. Earth
3. Venus

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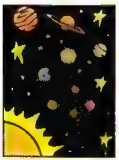
Venus

Venus is called Earth's "twin" because the two neighboring planets are similar in size. But there are more differences than similarities between the two.

3 Venus is the second planet from the sun.



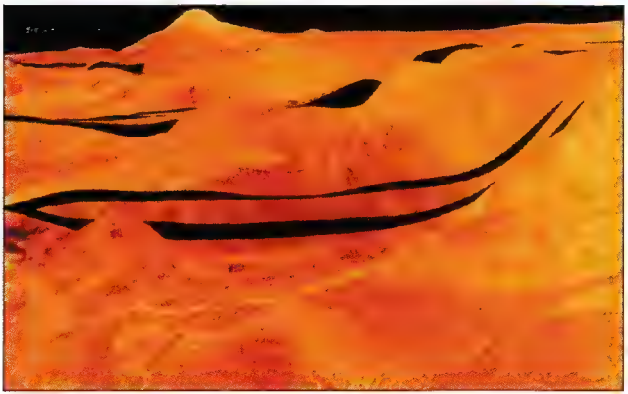


Photo © Sipa Icono

This photo of the surface of Venus, taken in 1991 by the space probe Magellan, clearly shows volcanoes, craters, and lava flows.

Venus is surrounded by thick clouds of sulfuric acid so scientists had difficulty learning about the planet's surface. But with the help of radar, radio-telescopes, and space probes, they've finally been able to explore Venus. The planet's surface is dry and hot—temperatures reach about 864° F (462° C)—and it's dotted with volcanoes and lava flows.

Turning in Space

Venus takes 225 Earth-days to revolve around the sun. Earth's trip takes longer (365 days) because it's further from the sun—the third planet away. But unlike Earth, Venus doesn't rotate on its axis in the same direction in which it revolves around the sun. Heading in the opposite direction, Venus turns on its axis once every 243 Earth-days—Earth turns on its axis every 24 hours.

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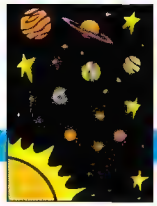
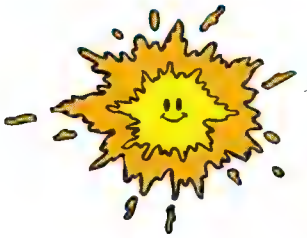
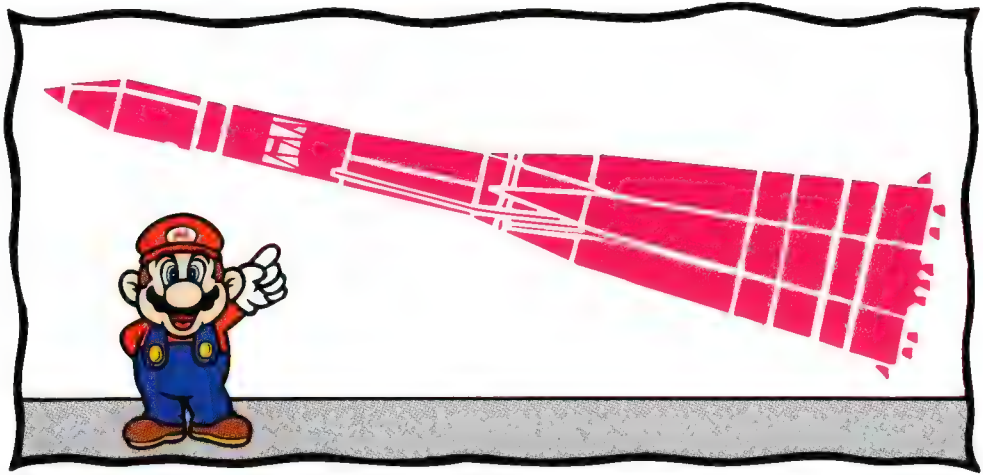
Who was the first human in space?



THE UNIVERSE



1. John Glenn
2. Neil Armstrong
3. Yuri Gagarin



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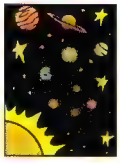
Yuri Gagarin

Yuri Gagarin (1934-1968), a Russian cosmonaut, was the first human in space. Before Gagarin's voyage, only animals such as dogs and monkeys had been launched into space and returned alive.

3 **Russian Yuri Alekseyevich Gagarin was the first human in space.**



© Y. Tabarés

Yuri Gagarin became a Russian hero after his historic flight into space.

Russian Yuri Gagarin was born not far from Moscow, near the city of Gzhatsk, a city now known as Gagarin in his honor. Gagarin the cosmonaut (Russian for astronaut) made history on April 12, 1961, when he orbited Earth once, becoming the first human in space.

Historic Orbit

On his Vostok I mission, Gagarin's spacecraft circled Earth at about 17,000 miles (27,400 km) per hour. At the highest point of the orbit, the capsule was about 203 miles (327 km) above Earth. Gagarin's entire voyage, from liftoff to landing, lasted 1 hour and 48 minutes—the orbit itself took 89.1 minutes.

A Hero's Welcome

Gagarin, hailed as a hero, was made a Deputy to the Supreme Soviet in 1962. (At that time, Russia was known as the Soviet Union.) Gagarin died in a plane crash in 1968.

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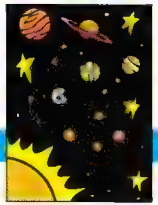
Who first used the telescope to study the stars?



THE UNIVERSE

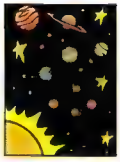
1. Galileo
2. Copernicus
3. Ptolemy

©1995 Nintendo

Galileo

It's believed that the first telescope was built in 1608 by Dutch eyeglass-maker Hans Lippershey. But it was an Italian, Galileo Galilei (1564-1642), who first used the telescope to study the skies.

1 Galileo was the first to use the telescope to study the stars.



© VIP / Sipa Icono

Galileo perfected the telescope, he didn't invent it. His models were larger and more powerful than those made previously.

In 1609, Galileo built a telescope to magnify things three times their size. He later made one to magnify things 33 times their size. He studied the sky and saw that Ptolemy, a Greek astronomer who said the sun and planets revolved around Earth, was wrong. Copernicus, a Polish astronomer who said all planets, including Earth, revolved around the sun, was right.

Galileo's Discoveries

Galileo discovered mountains on the moon, and in 1610, found four moons that orbited Jupiter. While observing stars invisible to the naked eye, he discovered that the Milky Way was made of thousands of stars. Galileo's other discoveries include the law of free falling bodies—all objects fall at the same speed, regardless of their mass.

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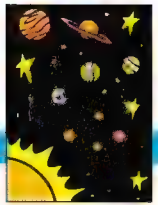
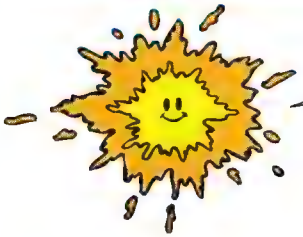
Which is the smallest planet in our solar system?



THE UNIVERSE



1. Neptune
2. Uranus
3. Pluto

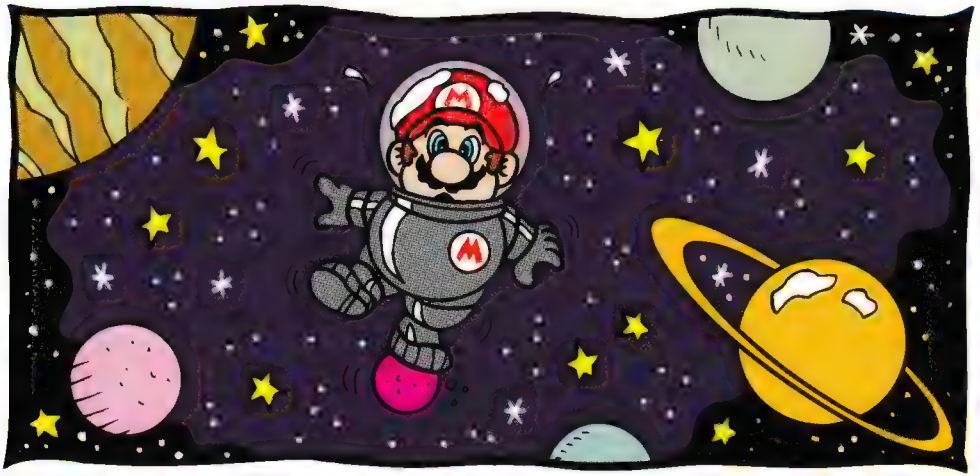


Illustration Gary Fields

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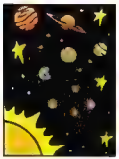
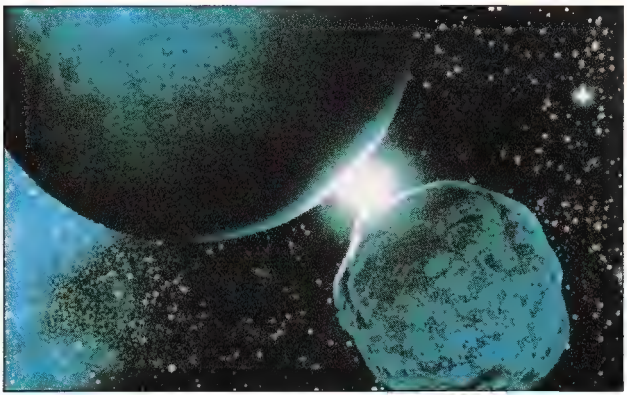
Pluto

Pluto was named after the Roman god of the underworld, because it is so small and far from the sun that it is always in the dark. Even the most powerful telescopes only see it as a tiny dot of light.

3 Pluto is the smallest planet in our solar system.





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Scientists are hoping to send a spacecraft to explore Pluto and Charon in the year 2001.

Some people consider Pluto the most mysterious planet because it is so far away. It was the last planet to be—astronomers discovered it in 1930—and no spacecraft has ever explored it. It is about 3 billion miles (4.5 billion km) from the sun which makes it a very cold planet with a temperature averaging 400°F (204°C) below zero.

In 1978 an astronomer discovered that Pluto had one moon. This moon was named Charon after the ferryman who, according to myth, brought the poor souls to Pluto's underworld.

Composition of the Planet

Pluto is made up of a rocky core surrounded by a thick coat of ice which in turn is covered by a crust of frozen methane gas approximately three miles thick.

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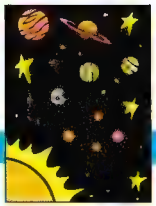
Which planet is closest to the Sun?



THE UNIVERSE

1. Mars
2. Neptune
3. Mercury

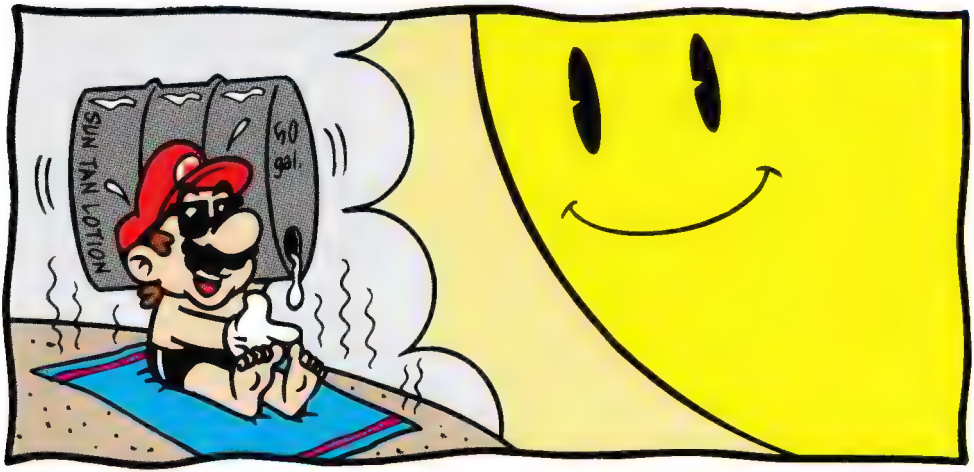


Illustration Gary Fields

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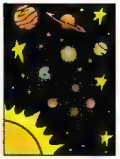
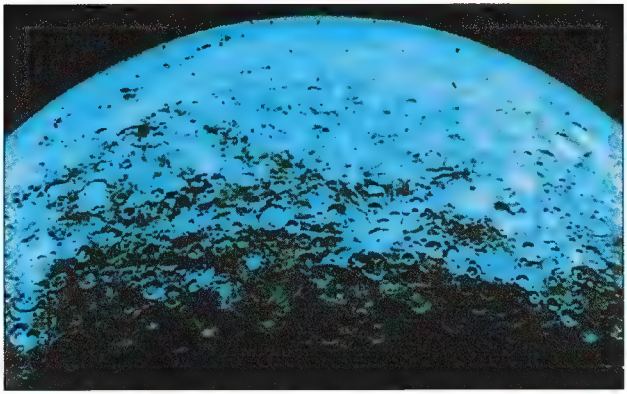
Mercury

Because it is so bright, astronomers could spot Mercury from Earth long before telescopes were invented.

3 Mercury is the closest planet to the Sun.





© Len Sirman

The surface of Mercury, dotted with craters, looks a lot like the Moon's.

Mercury was named after the Roman fleet-footed messenger of the gods because of how quickly it orbits the Sun—in only 88 days. It turns on its own axis, but so slowly that one day on Mercury is as long as 180 Earth days.

Mercury is the second-smallest of the planets after Pluto. It is a difficult planet to approach because it is so close to the sun, but in 1974 the U.S. Mariner 10 spacecraft was able to get close enough to take some good pictures of Mercury. Scientists say that it has a large iron core, like Earth.

Hot Planet

Because it is so close to the sun, Mercury's temperatures can go up to 750°F (399°C) during the day. But because it has no atmosphere to hold in the heat at night, it can get as cold as 300°F (148°C) below zero.

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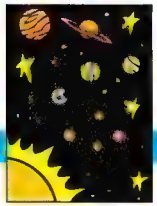
What is an observatory?



THE UNIVERSE

1. A green house
2. A music room
3. A place from which to study celestial objects

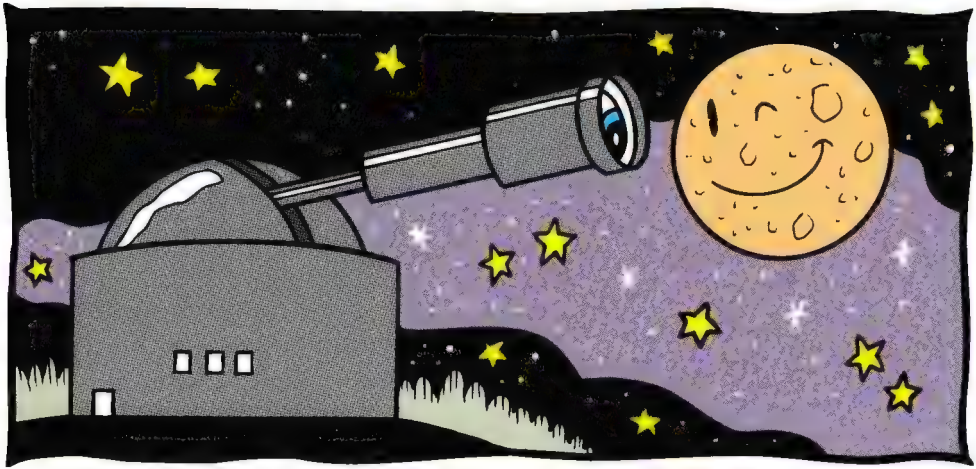


Illustration: Gary Fields

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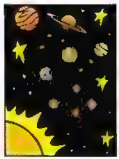
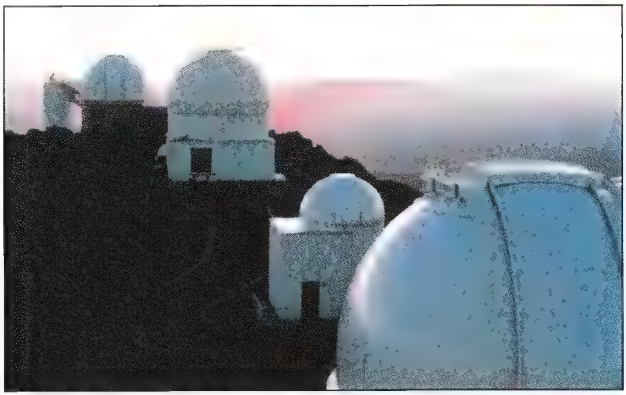
An Observatory

An astronomical optical observatory is a building equipped with telescopes and other instruments for observing the stars, planets, and other celestial objects such as comets and meteors.

3 An observatory is a place from which astronomers study celestial objects.





© Len Sirman

Kitt Peak observatory in Arizona is dedicated primarily to the study of the Sun.

An astronomical observatory is any place from which the skies are observed. Some historians believe that Stonehenge, in England, built about 2000 B.C., was an observatory. They think that the stone circles at Stonehenge were used to predict eclipses.

The 15th century Italian astronomer, Galileo, using his primitive telescope, made some exciting discoveries concerning the motion of the planets and the stars. These discoveries inspired the construction of optical observatories throughout Europe.

Star gazing from mountaintops

Today there are hundreds of sophisticated astronomical observatories all over the world. Most observatories are located on mountaintops where the air is free of dust, pollution, and where tall buildings and city lights won't impede the view of the skies.

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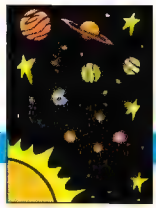
How big is Saturn compared to Earth?



THE UNIVERSE

1. Half the size of Earth
2. Twice as large
3. 744 times bigger than Earth

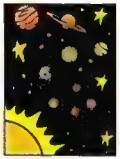
Illustration: Gary Fields

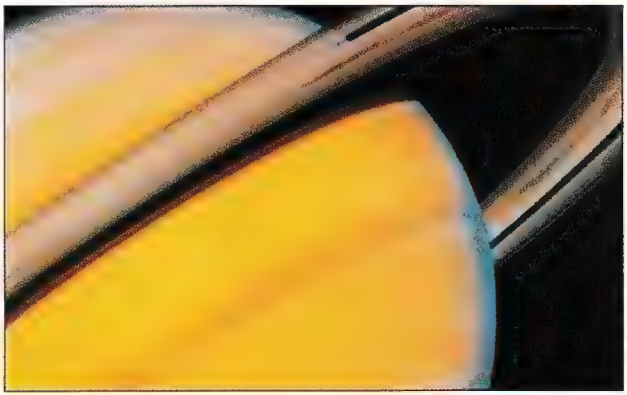
©1995 Nintendo

Saturn

Saturn, the ringed planet, was named after the Roman god of agriculture. It is the second-largest planet in the solar system after Jupiter and the sixth planet from the sun. Saturn is composed mostly of hydrogen and helium gases.

3 Saturn is 744 times bigger than the Earth.





© Sipa Press (NASA)

Close-up photograph of Saturn taken by Voyager 2.

In 1610, Galileo Galilei looked through his primitive telescope and noticed a planet, Saturn, which appeared to have two small bodies near it. Later astronomers concluded that these "bodies" were actually rings around the planet.

Photographs of Saturn

In 1980 and 1981 when spacecrafts Voyager 1 and 2 took pictures of Saturn, it became very clear that this big planet was surrounded by tens of thousands of rings extending for thousands of miles beyond its atmosphere. Saturn's rings are made of ice-covered particles. Some particles are tiny as a speck of dust while others are as huge as an iceberg. If you look at Saturn with a good telescope today, you can see a light yellow and gray-banded sphere-like shape flattened at the poles. It is quite an unusual and fascinating sight.

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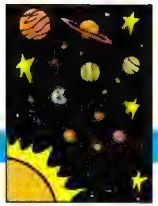
D3 054 30-06

How many satellites does Uranus have?



THE UNIVERSE

1. Five
2. Ten
3. Fifteen

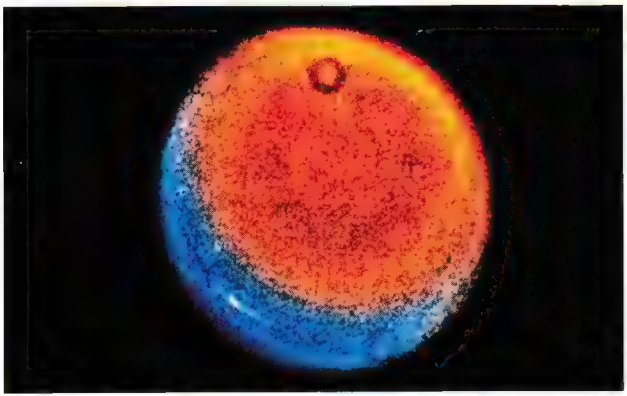
Illustration: Gary Fields

©1995 Nintendo

Uranus

Uranus is the seventh planet from the sun. It named after the mythological father of the Titans.

3 Uranus has fifteen satellites.



© Len Sirman

Uranus's blue tint is believed to be due to methane gas.

Uranus was discovered in 1781 by William Herschel. Like Saturn, it is composed of gases such as helium and hydrogen but it also has trace amounts of methane gas in its atmosphere which give it a greenish-blue color.

Fifteen Satellites

The five major satellites of Uranus are Miranda, Ariel, Umbriel, Titania, and Oberon. These five, plus the other ten satellites, seem to be synchronized as they rotate around Uranus, keeping the same face toward Uranus as they orbit.

The rings around Uranus are different from those of Saturn. Uranus's rings are sharp-edged and appear to be composed of dark material; not like the bright, icy rings of Saturn.

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What is the Big Bang?

THE UNIVERSE

1. A nuclear power plant explosion
2. An astronomical theory
3. A dynamite trademark

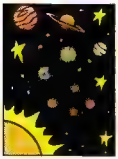
Illustration Gary Fields

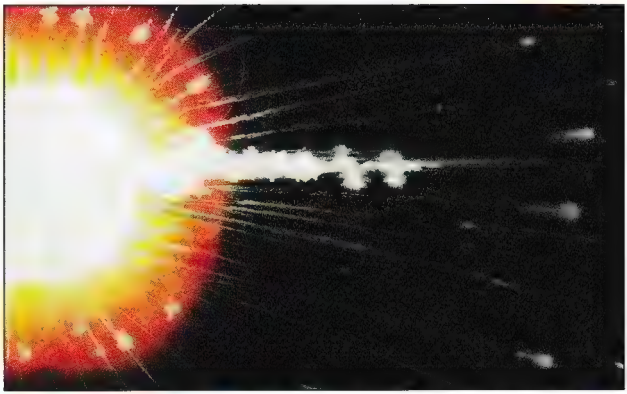
©1995 Nintendo

Big Bang

The universe contains planets, and galaxies—huge collections of stars—and everything in between. According to the Big Bang Theory, the universe was formed by a massive explosion about 15 billion years ago.

2 The Big Bang is an astronomical theory.





© Y. Tabarès

Right after the Big Bang, the universe was very small. Then it began expanding in every direction.

The Big Bang Theory of the birth of the universe was developed in 1927 by Georges Lemaitre, based on the work of Albert Einstein. The theory is that before the Big Bang occurred, there was nothing. Then, within a very tiny fraction of time—less than a quadrillionth of a second—enough energy came together to create everything that is now part of the universe.

One clue that supports the Big Bang Theory is that galaxies still seem to be expanding outward. Also, in 1965, astronomers found evidence of a very weak source of heat in space, which they believe is energy left over from the Big Bang. When the universe was born, it was extremely hot: about 50 billion° F (10 billion° C)! It had to cool to about 5,500° F (3,000° C) before atoms—the smallest unit of matter—could form.

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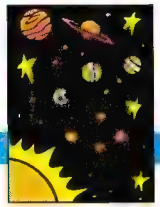
How big is the universe?



THE UNIVERSE

1. 10 times the size of our galaxy
2. 400 times the size of our galaxy
3. Infinite

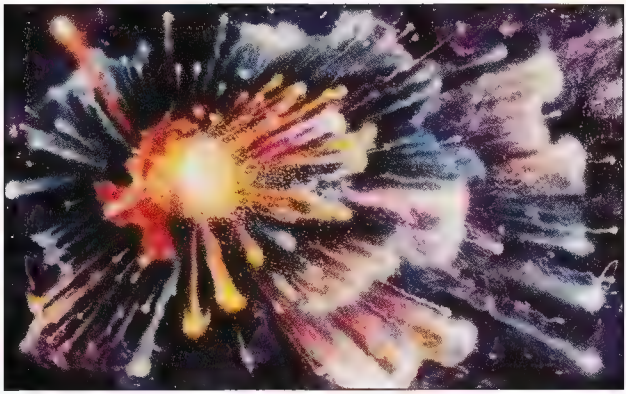
Illustration: Gary Fields

©1995 Nintendo

The Universe

While it's hard to imagine, the universe is believed to be infinite —without end.

3 The universe is infinite.



© Michael Carroll, from *The Star* published in U.K. by Tamarind Press

An artist must use his or her imagination to show the Big Bang.

Cosmologists are scientists who study how the universe began and what will become of it in the future. They believe the universe was developed during the "Big Bang"—about 15 billion years ago.

Here's one way to think of the size of the universe: Imagine that the universe is a hollow sphere the same size as Earth (diameter 7,926 miles [12,756 km]). Then the Milky Way—our galaxy—would measure 130 feet (40 m) across. The nearest star would be 4.2 light-years away (a light-year is the distance light travels in one year). The star would measure less than an eighth of an inch (1.3 mm), and Earth would be nothing but a tiny speck measuring 0.0000000004 mm across! Light travels 186,000 miles per second (300,000 km) but distances in space are so great that light from the nearest stars—the ones we can see—still takes years to reach us. Light from far away galaxies takes billions of years to reach Earth. What we see is how the galaxies looked a long time ago. Because of this, astronomers are able to observe objects formed when the universe was young.

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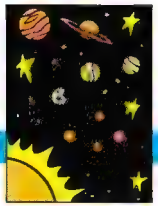
What is a red giant?



THE UNIVERSE

1. A brand of frozen vegetables
2. A type of tractor
3. A cooling star at the end of its nuclear combustion stage

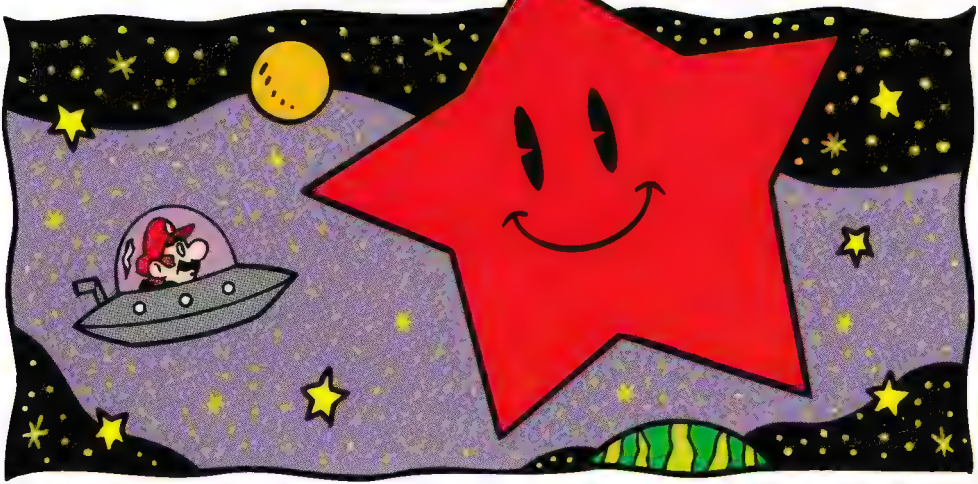


Illustration: Gary Fields

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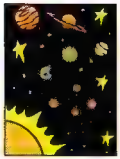
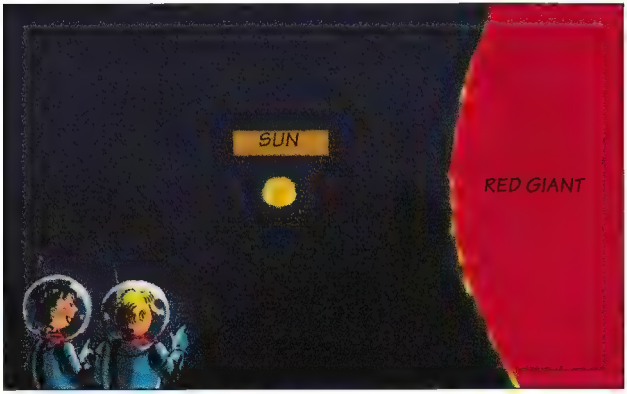
Stars

Stars go through different cycles over the course of their lives, just as humans do. The kind of life a star has depends on how much material it contains.

3 A red giant is a cooling star at the end of its nuclear combustion stage.





© Y. Tabarès

Red giants are much brighter than the sun.

Stars are born as nebulae in a huge cloud of gas and dust. Eventually, the nebulae shrink and then break up into a cluster of smaller stars with varying degrees of brightness. Each of these stars has a different lifetime depending on its mass, or the amount of material it contains—the more mass, the shorter its lifespan.

Red Giants

Medium-hot and very hot, bright stars spend most of their lives shining steadily and burning the element hydrogen into another element, helium. This process is known as nuclear combustion. During this time the star slowly becomes hotter and brighter. When the star's core of used helium reaches a certain size, the core collapses from its own gravity and becomes hotter still. Eventually, its outer layers cool and turn reddish in color and it is known as a red giant.

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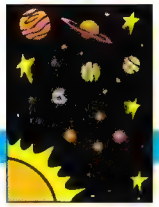
What is a white dwarf?



THE UNIVERSE

1. The remains of a star after it has become a red giant
2. A species of miniature horse
3. A mountain flower

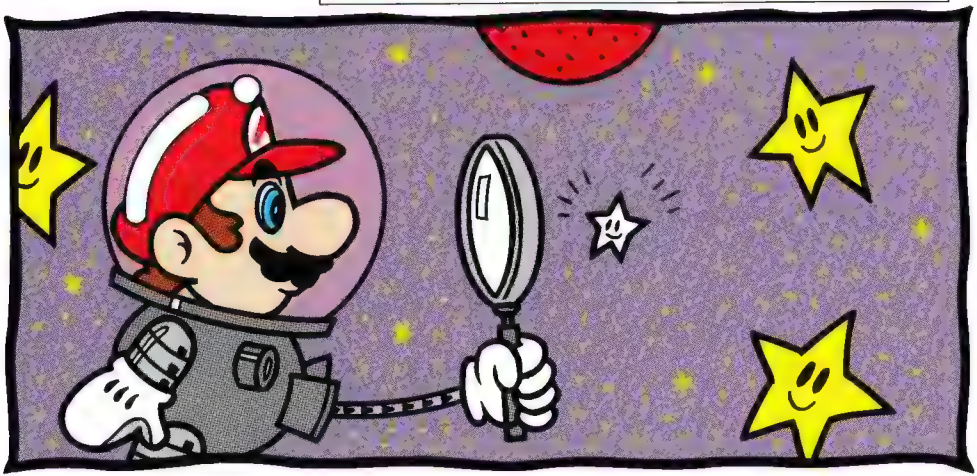


Illustration: Gary Fields

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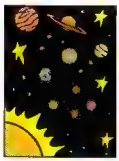
Stars

All stars give off light and heat. The amount of light and heat they produce depends on the stage they have reached in their life cycle.

1 A white dwarf is the remains of a star after it has become a red giant.



© Y Tabarés

White dwarf stars are small but extremely dense.

Very hot and bright stars might shine at full force for only a few million years before using up their supply of hydrogen and helium—their fuel. When a star's core runs out of fuel, it collapses. When stars much more massive than our Sun collapse, they give off so much energy that the star is blown to bits. When smaller stars like the Sun collapse, they shrink and become classified as white dwarves—dense, hot bodies about as big as a small planet.

Atoms—the smallest units of matter—in a white dwarf are packed together hundreds of times more tightly than in a normal star. The surface of a white dwarf is very hot, but because it has shrunk it is less than a hundredth as bright as the Sun.

Other Stars

Not all stars shine at constant levels like the Sun. Variable stars change greatly in brightness over the course of years or even days. Pulsars are stars that spin rapidly.

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What is a galaxy?

THE UNIVERSE

1. A vast collection of stars
2. A telecommunications tool
3. A popular dance

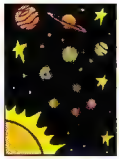
Illustration: Gary Fields

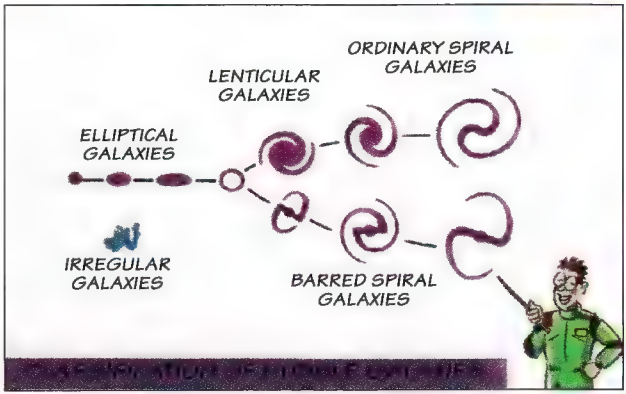
©1995 Nintendo

Galaxies

Galaxies are groups of stars. Dwarf galaxies may contain only a few million stars, and giant galaxies can contain many millions of stars. Galaxies also exist in groups, called clusters.

1 A galaxy is a vast collection of stars.





© Y. Tabariès

These are the different configurations of a galaxy.

Our galaxy, the Milky Way, belongs to a cluster of 32 galaxies, called the Local Group. Most of the other galaxies in this group are small and distant. Astronomers classify galaxies according to their shapes. The gravity of nearby, larger galaxies can pull smaller galaxies out of shape. This is the case of the Magellanic Clouds, which are pulled by the gravity of the Milky Way. Galaxies can also be elliptical, or oval, in shape. The largest known galaxies are elliptical. Spiral galaxies are broken into subclasses, depending on the size of their nucleus, or center.

Our Galaxy

The Milky Way is believed to be a barred spiral galaxy, that is, its nucleus is a short bar of stars, and its spiral arms extend from the ends of this bar. Of the known galaxies in our Local Group, the Milky Way, is the second largest.

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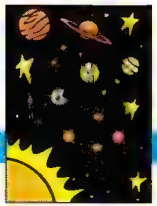
What is the photosphere?



THE UNIVERSE

1. A camera focusing feature
2. The shining surface of the Sun
3. A telescope lens

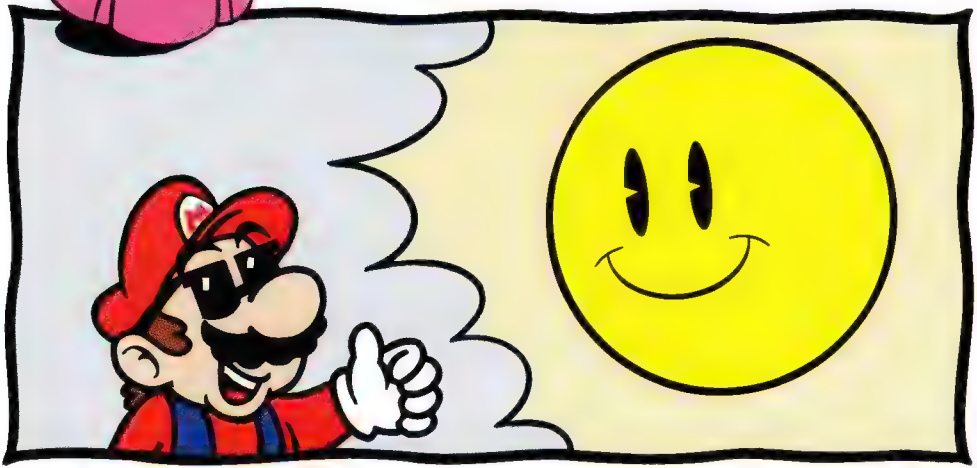


Illustration: Gary Fields

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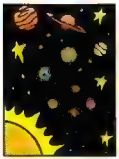
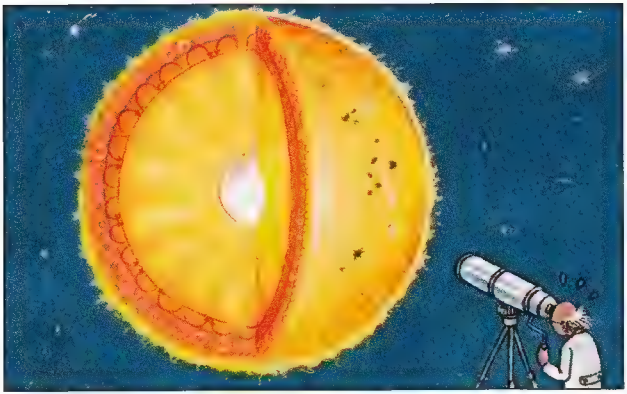
Photosphere

The photosphere is the visible surface of the Sun. It produces almost all the light we actually see.

2 The photosphere is the shining surface of the Sun.





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The Sun will continue to shine as it does today for more than a billion more years.

The Sun's energy is produced at its core. This energy then radiates outward to the convection zone, where the weakened energy waves violently churn to the Sun's surface layer, called the photosphere. The Sun is nearly 900,000 miles in diameter, but the photosphere is only about 130 miles (200 km) thick. The temperature at the center of the Sun is about 27 million° F (15 million° C). By comparison, the temperature in the photosphere is only about 10,800° F (5,900° C).

Solar Granulation

Turbulent areas in the photosphere make the surface of the Sun appear irregular. This pattern, called solar granulation, is caused by turbulence in the convection zone just beneath the photosphere. Each granule is about 1,240 miles (2,000 km) across, though they look tiny from Earth. Flares are violent explosions that usually occur over sunspots, the cooler areas on the surface of the Sun, which appear dark.

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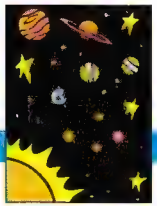
What is a constellation map?



THE UNIVERSE

1. An automobile club membership feature
2. A tool for astronomical observation
3. A game show prize

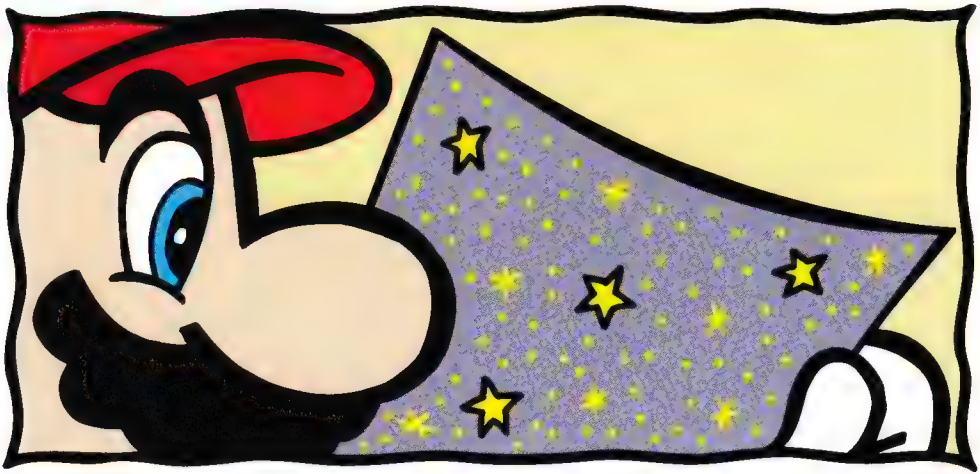


Illustration: Gary Fields

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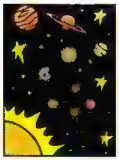
Constellations

Constellations are not merely groups of stars, they are areas in space with specific boundaries.

2 A constellation map is a tool for astronomical observation.



© Explorer

Twelve constellations represent each sign of the zodiac. Half are visible in the Northern Hemisphere, and the rest are visible in the Southern Hemisphere.

In 150 A.D., the Greek astronomer Ptolemy recorded 48 star patterns. Actually, many of the constellations he mentioned had been described before 2000 B.C. by Babylonian astronomers. In Ptolemy's time, explorers traveled to lands in the Southern Hemisphere where they observed parts of the celestial sphere they had never before seen.

Mapping Constellations

Constellation maps show the sky's major constellations. Small dots indicate fainter stars, barely visible to the naked eye. Larger dots represent brighter stars. Connecting these dots on a map reveals the overall shape of the constellation. There are 88 constellations in all; named for everything from animals to musical instruments to mythical heroes. The smallest is Crux (the Cross), and the largest is Hydra (the Water Snake).

The constellations we see vary, depending on our location on Earth and the season. The way the Earth tilts changes our view of the sky.

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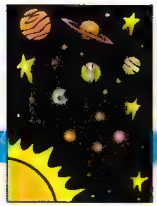
How many years does it take Mars to orbit the Sun?



THE UNIVERSE

1. Five years
2. Less than two years
3. More than seven years

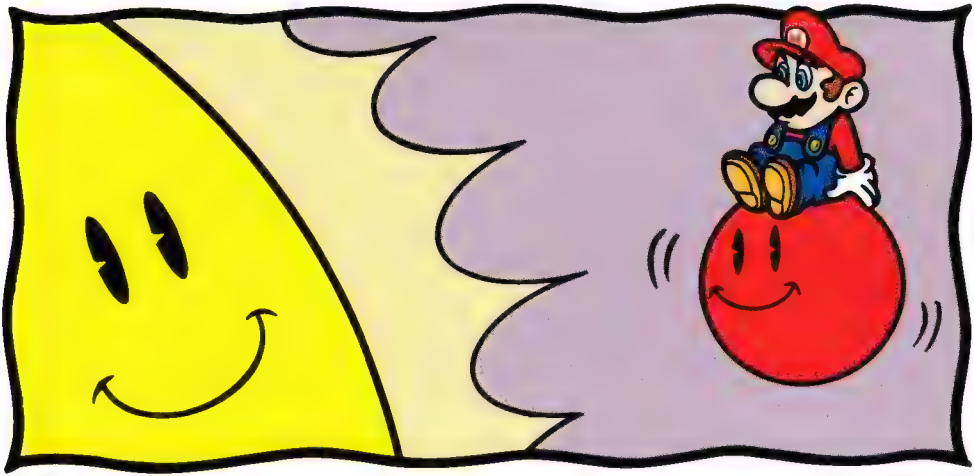


Illustration Gary Fields

©1996 Nintendo

Mars

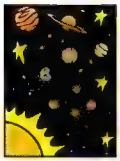
Mars is the fourth planet from the Sun, between Earth and Jupiter. Mars is much smaller than Earth and is about one-tenth Earth's weight.

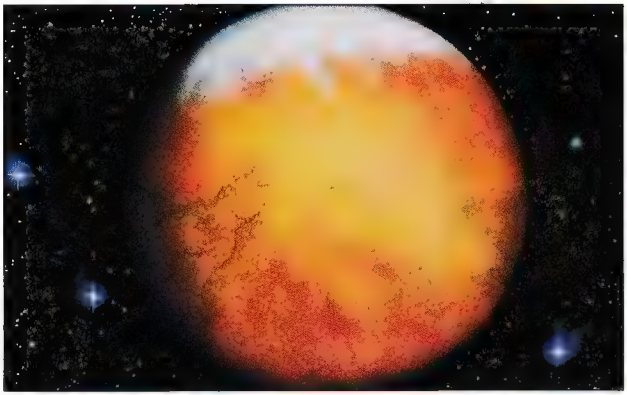
Mars is often called the Red Planet because its atmosphere, contains red dust from its surface. When Mars was young, it had a warmer, wetter climate. At that time, the abundant iron on its surface rusted and became reddish in color.

Life on Mars?

Less than a century ago, many people believed there was life on Mars. The Voyager space missions in 1976 determined that Mars is unable to support life.

2 Mars orbits the Sun in a little less than two Earth years.





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There is no liquid water on Mars because its climate is too cold. Its poles are capped with ice, just like the poles of Earth.

Mars' craggy surface shows evidence of volcanic activity. There are also winding valleys where rivers might once have flowed—about 4 million years ago, the Martian climate might have been warm enough for water to exist in liquid form.

A day on Mars—the time it takes to make a complete rotation on its axis—lasts 24 hours and 37 minutes. A Martian year—the time it takes the planet to make one full trip around the Sun—lasts 687 Earth days.

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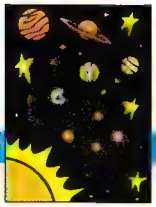
Is Earth the only planet with a satellite?



THE UNIVERSE

1 Yes

2 No

Illustration: Gary Fields

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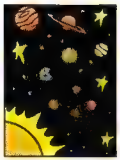
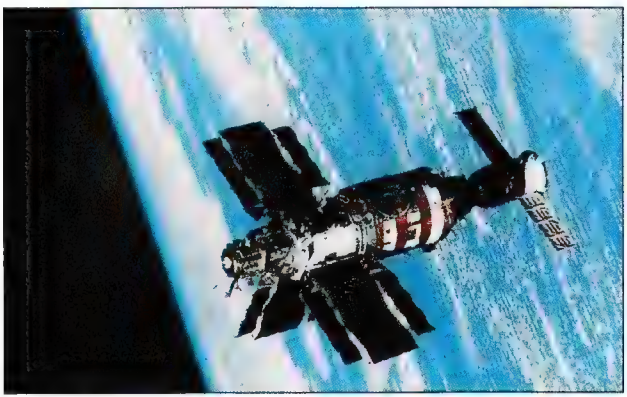
Satellites

A satellite is a body that orbits a planet. Natural satellites are called moons. Most of the planets in the solar system have at least one moon.

2 **No, many other planets besides Earth also have natural satellites.**





© Len Sirman

There are 60 natural satellites known today in the solar system. Artificial satellites like that shown above collect information on distant planets, such as Saturn, and send it back to Earth.

Most satellites are much smaller than the planets they orbit. The Moon is one-fourth the diameter of Earth. The Moon goes through month-long cycles as its position shifts relative to the Sun. During the first half of its cycle, the Moon waxes, or appears to grow. We see it first as a thin sliver, or crescent, then gradually becoming a circle. When the Moon is full, its entire sunlit surface faces Earth, and it appears round. Then the Moon begins to wane, or decrease in size, until we see nothing—the New Moon.

Artificial Satellites

Artificial satellites are spacecraft put in orbit around a planet. The artificial satellites orbiting Earth are either military satellites, used for spying or guiding weapons; communications satellites, which send television, telephone, and radio signals; scientific research satellites; or weather satellites used for forecasting the weather.

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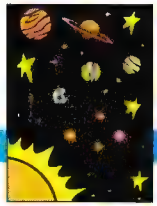
What are maria?



THE UNIVERSE

1. Church hymns
2. The Moon's vast lava plains
3. Salt water marshes

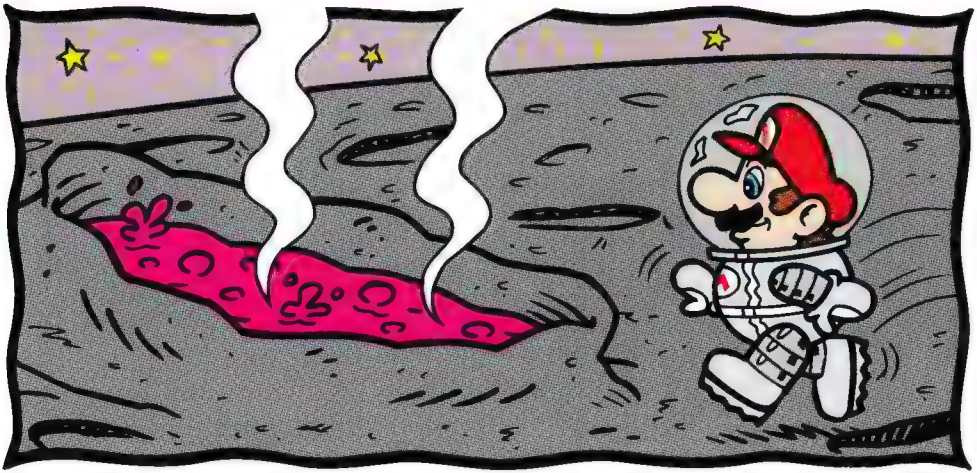


Illustration: Gary Fields

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Surface of the Moon

Samples of the Moon's surface show that its composition is very different from Earth's. Astronomers are still uncertain about how the Moon was formed.

2 Maria are the Moon's vast lava plains.

© Explorer / Van Waay Grafik

Most of the Moon's craters were formed when other bodies collided with it.

There are three main theories about how the Moon was formed. According to one, the Moon was passing by Earth and got caught in the Earth's gravity. Another theory states that the Moon broke off from the Earth when the Earth collided with another planet-sized body. Yet a third theory states that the Moon and Earth were formed at the same time, from a cloud of debris left by the formation of the Sun.

Frozen in Time

The Moon still has craters from bodies that crashed into it over 3 billion years ago. The far side of the Moon—the portion we cannot see from Earth—is covered with mountain chains that form ridges around huge, ancient craters. The side we see is covered with vast lava plains, called maria; the result of Earth's gravity, which pulled and cracked the Moon's surface and caused lava to flow through the cracks. This lava flooded the older craters and formed lava plains.

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Who sent the first spacecraft to the moon?

THE UNIVERSE

1. The United States
2. Russia
3. Canada

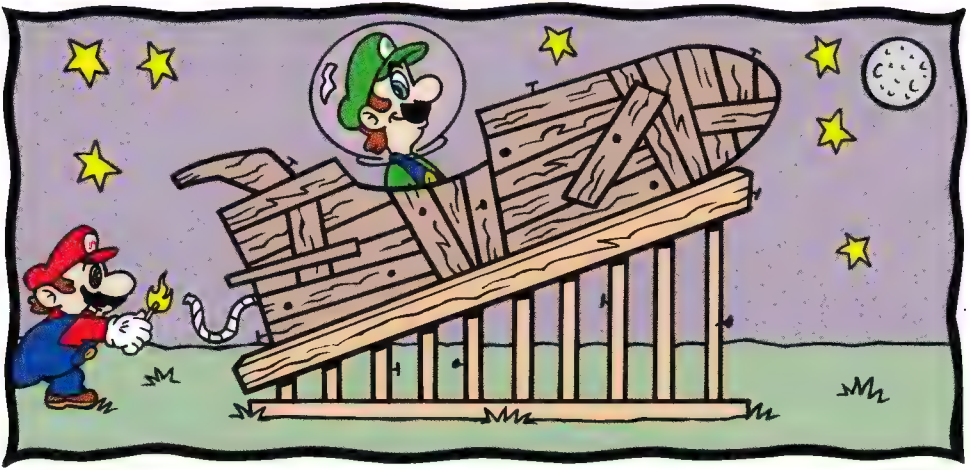

Illustration: Gary Fields

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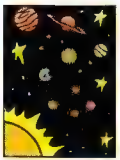
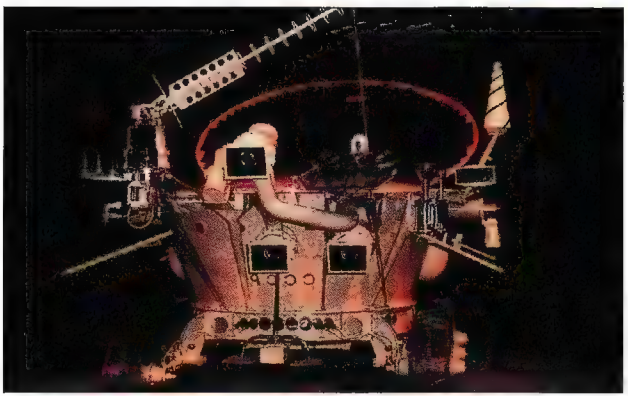
Moon Launches

In 1959, the unmanned Russian spacecraft, *Luna 3* gave us the first glimpse of the far side of the Moon.

2 Russia sent the first spacecraft to the moon.





© Len Sirman

Lunokhod I, positioned by *Luna 17* in 1970, traveled 6.3 miles (10.5 km) over the surface of the Moon.

The goal of American Ranger missions, which followed the first Luna flights, was to take close-up shots of the moon before crashing into its surface. Just before hitting the Moon's surface, Ranger 7—launched on July 28, 1964—sent back to Earth 4,316 television images of the Moon from a height of about 1,120 miles (1,800 km) above its surface. This was our first close-up glimpse of the Moon.

Luna 9 Landing

In 1966, Russia successfully landed *Luna 9*, the first lunar probe to land without being destroyed—a soft landing. Then the Americans landed a series of Surveyor spacecraft.

In 1970, Russian-launched *Luna 16* took a sample of lunar soil, put it into a sealed container, and launched it back to Russia. *Luna 17* and *Luna 21* soft-landed several lunar vehicles that could be controlled from Earth. Called *Lunokhod*, meaning "moon-walkers," they were equipped with television cameras and solar batteries.

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Who launched the first space rocket?

THE UNIVERSE

1. The United States
2. Canada
3. Russia

Illustration Gary Fields

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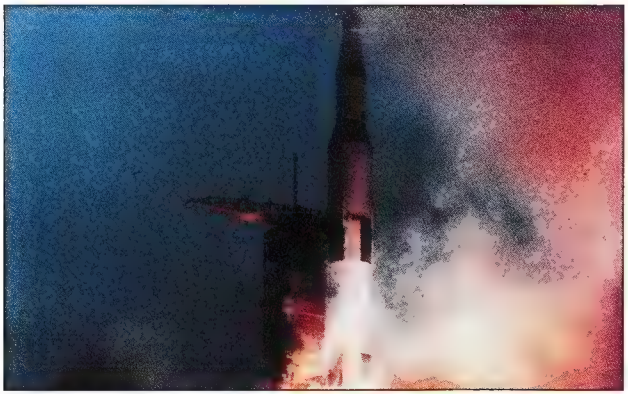
The Space Age

The Space Age began with the launching of the first artificial satellite, *Sputnik 1*, in 1957. Its full name, *Sputnik Zemli*, means "traveling companion of the world."

3 Russia launched the first space rocket.



© Len Sirman

Apollo is launched into space.

Launched by Russia in 1957, *Sputnik* was a spherical aluminum satellite measuring 23 inches (58 cm) in diameter and weighing 184 pounds (83 kg). It took 96.2 minutes to completely orbit the Earth. Inside *Sputnik* were instruments that recorded and transmitted information about cosmic rays, meteoroids, and the density and temperature of Earth's upper atmosphere.

Solar-Powered Satellite

Launched by the United States in 1958, the satellite *Vanguard 2* used solar power to transmit signals back to Earth for more than six years. Artificial satellites continue to orbit Earth until frictional force slows them down. When slight changes in orbit cause a satellite to pass through the atmosphere of Earth, it is slowed by friction with the air. Gradually, the orbiting pattern decays, and the satellite loses altitude until it reenters Earth's atmosphere, where it is burned up like a meteor.

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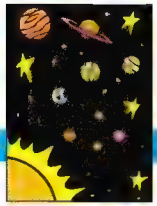
Are cosmonauts and astronauts the same thing?



THE UNIVERSE

1 Yes

2 No

Illustration Gary Fields

©1996 Nintendo

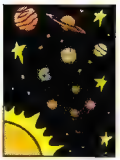
Cosmonauts and Astronauts

Cosmonauts and astronauts travel in spacecrafts and perform scientific experiments that would not be possible on Earth.

In 1961, Russian cosmonaut Yuri Gargarin became the first person to orbit Earth. That same year, Alan B. Shepherd became the first American in space. In 1962 American John H. Glenn became the first U.S. astronaut to orbit Earth.

The first woman in space was cosmonaut Valentina V. Tereshkova of Russia in 1963. Sally K. Ride became the first American woman in space in 1983.

1 Yes. Russian space travelers are called "cosmonauts," while Americans are called "astronauts."



© Len Sirman

People have spent months in orbit. A Russian cosmonaut spent 310 days in space!

Most of the first astronauts were military test pilots chosen by the American government to work for the U.S. space program. They were required to be under 40 years old, in excellent health, and no taller than 5 feet 11 inches (180 cm). In addition, they needed an undergraduate degree in engineering, at least 1,500 hours of flight time, and qualification as a jet pilot. Today, non-military applicants can become astronauts. Astronauts undergo rigorous training.

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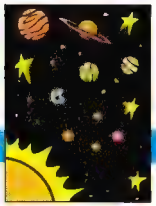
What is the Space Shuttle?



THE UNIVERSE

1. A luxury airline
2. A reusable spacecraft
3. A roomy high-speed train

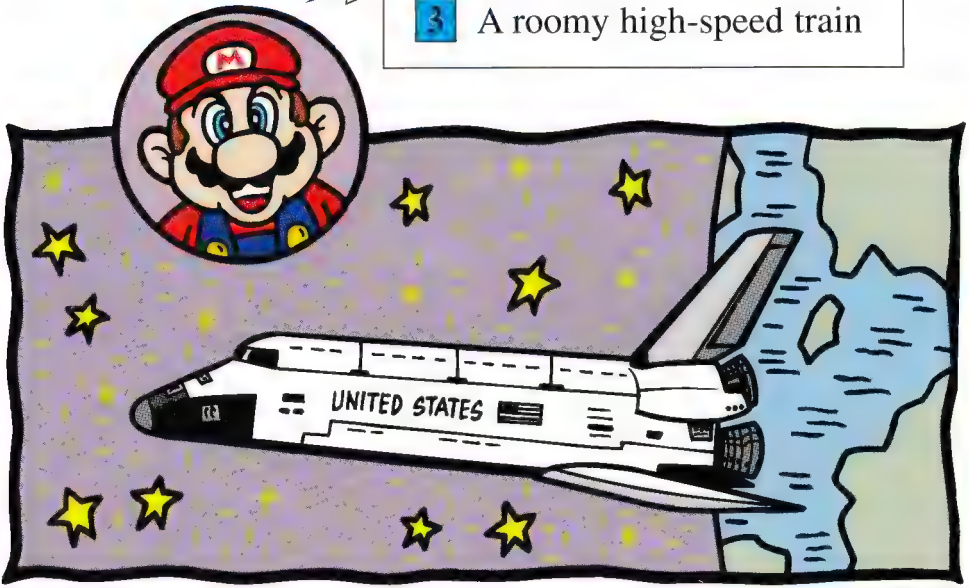


Illustration Gary Fields

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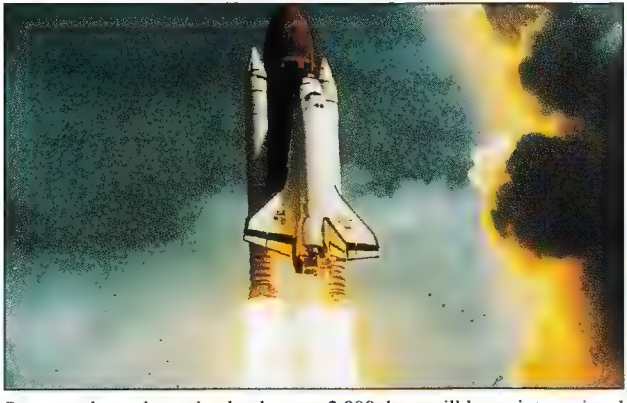
The Space Shuttle

The United States Space Shuttle Program began in the 1970s. The goal of the program was to create a reusable spacecraft.

2 The Space Shuttle is a reusable spacecraft.



© Len Sirman

Space explorers hope that by the year 2,000 there will be an international space station orbiting Earth, dedicated to the research of human survival in space.

Before the Space Shuttle, rockets and spacecraft were made for one-time use. After a mission, they were left in space or destroyed. The Space Shuttle was designed to return to Earth to be used again.

The Specs

The Space Shuttle is made up of three main parts, the orbiter, the external tank, and solid rocket boosters. The astronauts spend most of their time in the orbiter. When the Shuttle takes off the orbiter is a rocket, when in orbit it's a spaceship and when it returns to Earth it is a hypersonic glider. The external tank is the backbone of the Shuttle. Oxygen, hydrogen, and fuel are stored in the tanks. The solid rocket boosters propel the shuttle.

The Mission

The Space Shuttle was created to transport satellites, cameras, and other research equipment into space. Today there are four Space Shuttles. Each one can be reused 100 times within a 20-year period.

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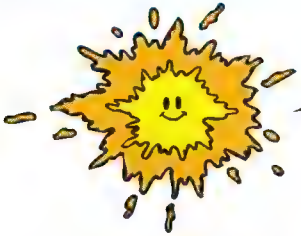
Who was Nicolaus Copernicus?

THE UNIVERSE



1. A conductor
2. A car designer
3. An astronomer

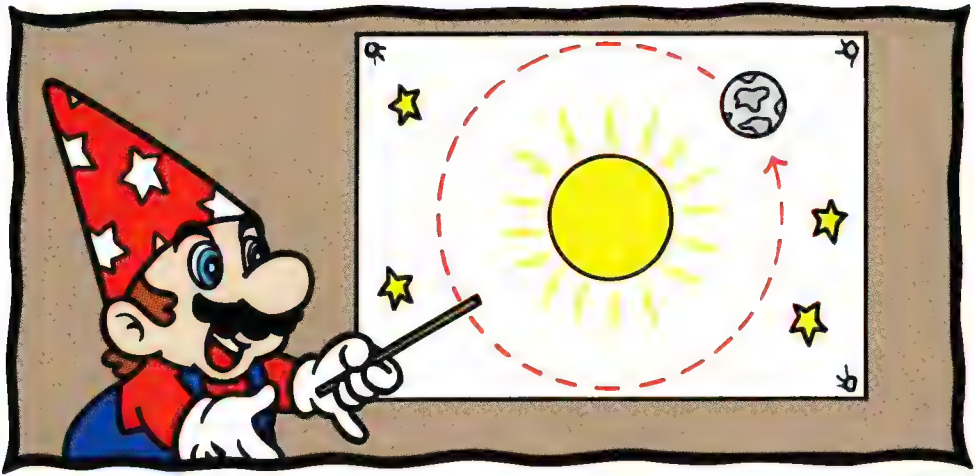


Illustration: Gary Fields

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Nicolaus Copernicus

Nicolaus Copernicus (1473-1543) helped prove that Earth revolves around the Sun.

3 Nicolaus Copernicus was an astronomer.

© Len Sirman

The work of Copernicus laid the foundation for modern astronomy.

Nicolaus Copernicus was born in Poland, where he studied mathematics, philosophy, and astronomy at the University of Krakow. Then he moved to Italy and studied liberal arts, law, and medicine. For a time, Copernicus was a Church official. He also worked as a doctor, but his real love was astronomy.

Controversy

Before Copernicus, people believed Earth was the center of the universe, and all the stars and planets revolved around it. But Copernicus was convinced that the Sun was the center of the universe. This was called the heliocentric theory from the Greek words *helios* and *kentrikos,* meaning "sun" and "center."

The Catholic church did not like the idea of the Earth not being at the center of the universe so they banned Copernicus and his beliefs.

Over the years several other astronomers, including Galileo, published papers which successfully convinced the world that the heliocentric theory was indeed correct.

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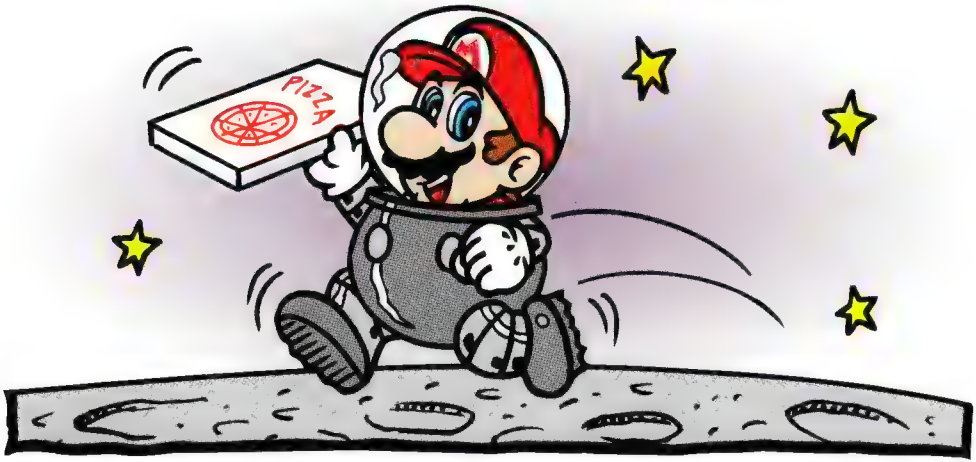
Who is Neil Armstrong?

THE UNIVERSE

1. The first man to walk on the Moon
2. The first man to sail around the world
3. The first man to eat fifty pizzas in one hour



Illustration, Gary Fields

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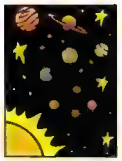
Moon Walk

United States President John F. Kennedy wished that a man would walk on the Moon before 1970. Neil Armstrong made that wish come true.

1 Neil Armstrong is the first man to walk on the Moon.



© National Aeronautics and Space Administration

Apollo II commander Neil A. Armstrong participates in simulation training at Kennedy Space Center in June of 1969.

On July 16, 1969, astronauts Buzz Aldrin, Michael Collins, and Neil Armstrong blasted off in a rocket and headed toward the moon. Four days later, their spacecraft began its orbit around the Moon. The craft included two pieces: the Command Module and the Lunar Module. On July 20, 1969, Buzz Aldrin and Neil Armstrong climbed into the Lunar Module which was then cut free from the command Module to descend to the surface of the Moon.

The World Watched

Hundreds of millions of people watched Neil Armstrong make history as the first man to set foot on the Moon. Upon landing he declared: "That's one small step for man and one giant leap for mankind." Other astronauts have since walked on the Moon, but Armstrong was the first. Since there is little erosion of the Moon's surface, his footprints are still visible today.

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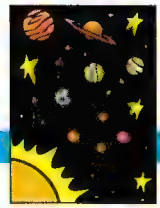
How many signs are in the zodiac?



THE UNIVERSE

1. Ten
2. Thirteen
3. Twelve

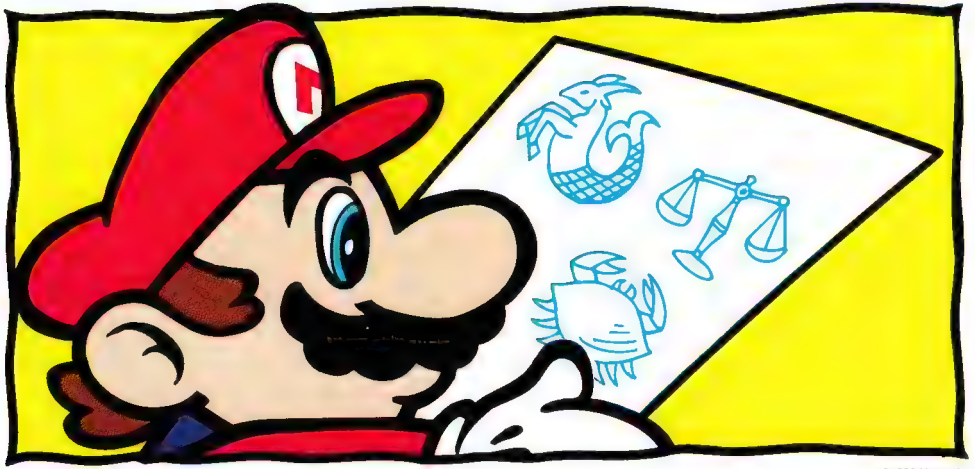


Illustration Gary Fields

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Zodiac

The zodiac is the zone in which the sun appears to move through the sky. The ancient Greeks believed that people's personalities and destinies could be forecast by the position of the sun at their births.

3 There are twelve signs in the zodiac.

© Len Surman

The signs of the zodiac were named after constellations, or groups of stars.

The signs of the zodiac were named after constellations, or groups of stars. Ancient Babylonians named the constellations according to what they looked like, and the Greeks adopted these names and gave them to the signs: Aries (the ram), Taurus (the bull), Gemini (the twins), Cancer (the crab), Leo (the lion), Virgo (the virgin), Libra (the scales), Scorpio (the scorpion), Sagittarius (the archer), Capricorn (the goat), Aquarius (the water bearer), and Pisces (the fish).

Stellar Predictions

Many people believe that astrology, the study of the zodiac, is a reliable source of understanding human nature, and many do not. Horoscopes—the daily, monthly, yearly or lifetime predictions of people's destinies, based on the zodiac—appear in many publications, including newspapers, magazines, and books.

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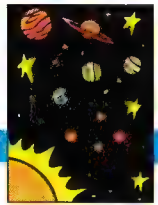
When was the solar system formed?



THE UNIVERSE

1. Approximately 1.7 billion years ago
2. Approximately 4.7 billion years ago
3. Approximately 10 million years ago

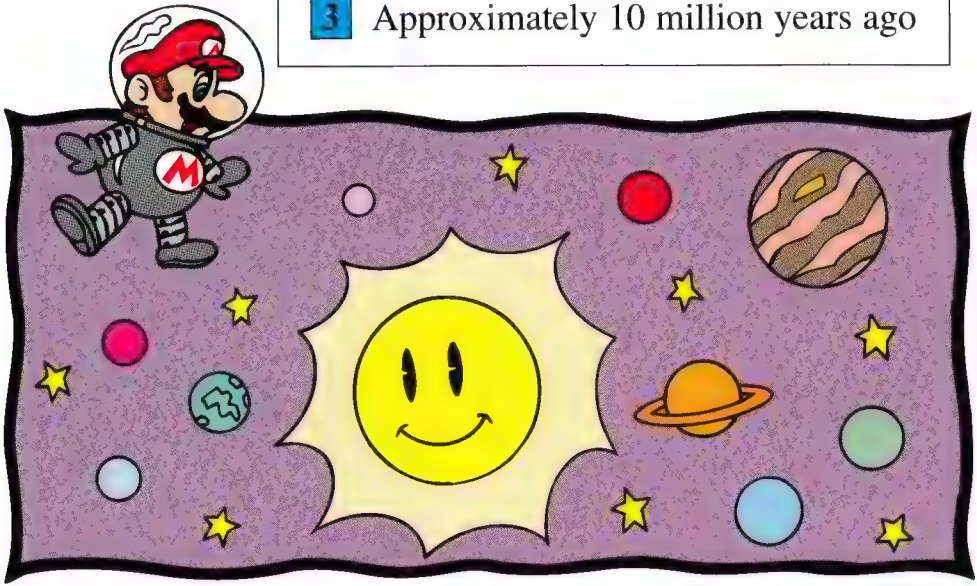


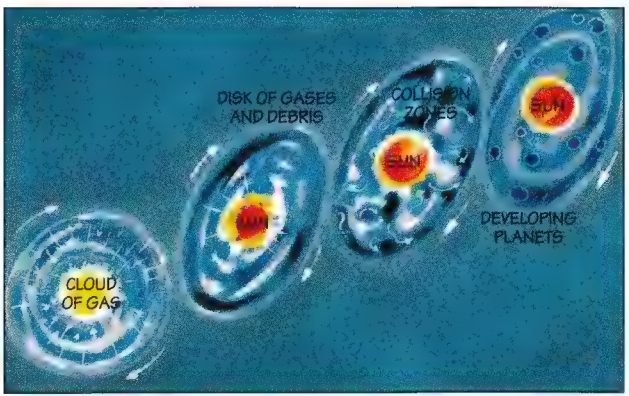
Illustration: Gary Fields

©1996 Nintendo

Solar System

Current theories connect the formation of the solar system with the formation of the Sun, which took place about 4.7 billion years ago when a huge cloud of gas and dust collapsed, possibly caused by an enormous explosion.

2 The solar system was formed approximately 4.7 billion years ago.



© Y Tabunès

The Solar System gradually developed from a huge cloud of dust and gas.

Despite the differences in the nine planets of our solar system, their moons, and the Sun, they seem to have been created at the same time. According to the current theory of origin, the members of the solar system were created when a very large cloud made up primarily of hydrogen, helium, and solid grains collapsed.

Why?

The chain of events might have been caused by the explosion of a supernova, an extremely bright star that emits light 10 million to 100 million times brighter than our Sun today. Our Sun did not exist at the time of the explosion, of course, but began to form at the center of the disk of gas and debris left behind. Gradually, the various types of solid matter orbiting around the developing Sun began to collide with each other, forming the bodies that today we call moons and planets.

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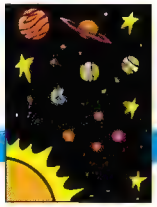
What does the future of the solar system hold?



THE UNIVERSE

1. It will continue as it is indefinitely
2. It will gradually expand
3. It will gradually die

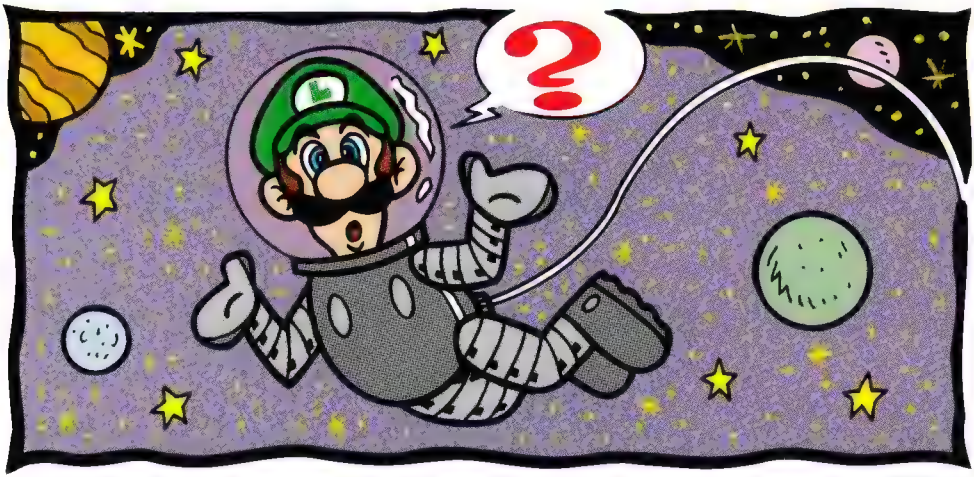


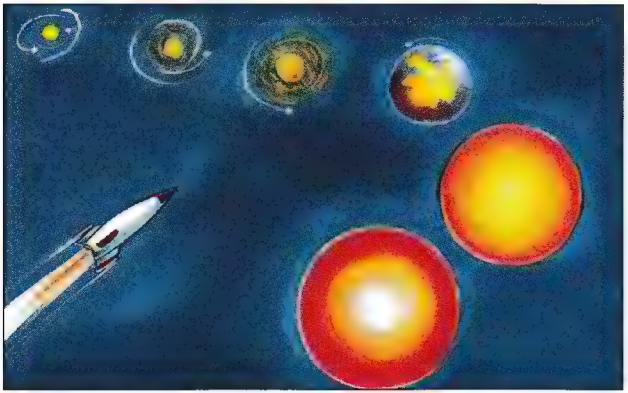
Illustration: Gary Fields

©1996 Nintendo

Solar System

The future of the solar system is linked to that of the Sun. Our Sun is still a young star, but some scientists believe they can predict its slow evolution and death over the next 5 billion years.

3 The solar system will gradually die over the next 5 billion years.



© Y. Tabariès

Some scientists suspect that a planet up to five times the mass of Earth is located several times as far from the Sun as Neptune.

Many exciting discoveries will be made in the 21st century. There may, for example, be planets beyond Pluto, the farthest known planet from the Sun. Scientists once believed that Uranus was the farthest planet from the Sun, until they realized that an unknown gravitational force was disturbing its orbit. Neptune, the planet beyond Uranus, was "discovered" on paper a year before it was actually seen. When all of the disturbances in Uranus' path could not be explained by the existence of Neptune, Pluto, the most distant planet, was discovered in 1930.

A Good Guess

While Pluto's gravitational forces play a role in the disturbed orbital paths of its neighboring planets, it is not massive enough to be entirely responsible. Scientists suspect that there is at least one more planet beyond Pluto.

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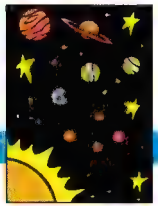
How big is the solar system?



THE UNIVERSE

1. 4 million miles from the Sun to Pluto
2. 4 billion miles from the Sun to Pluto
3. 4 trillion miles from the Sun to Pluto

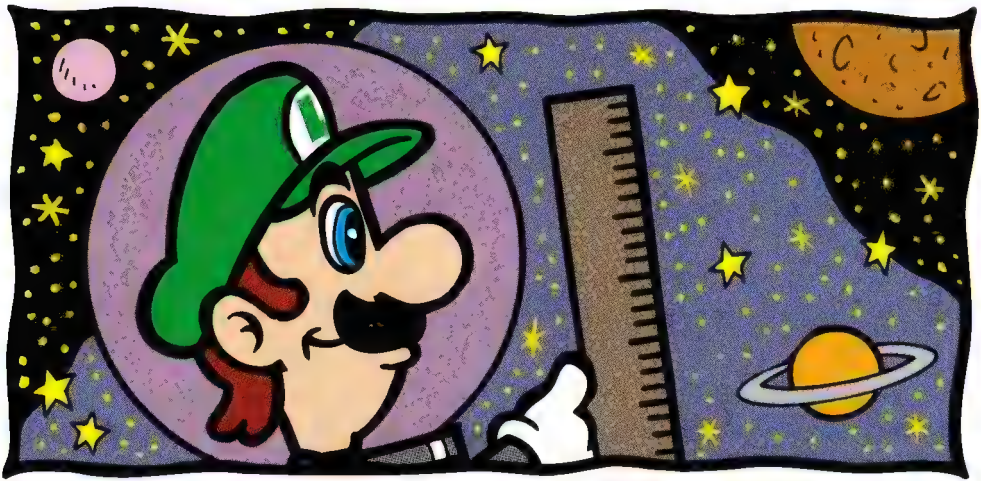


Illustration. Gary Fields

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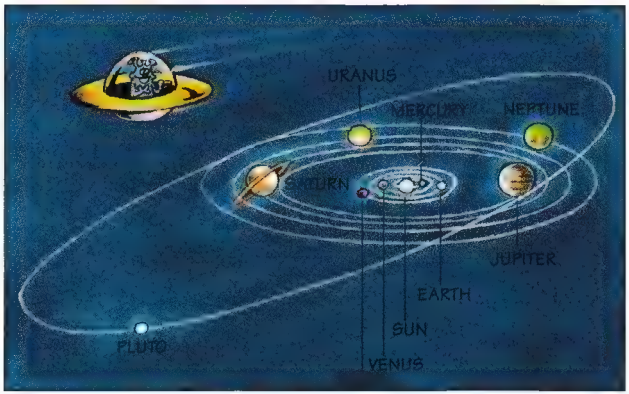
Solar System

Of the nine known planets orbiting our Sun, the farthest from the Sun is Pluto. Pluto is a cold, icy planet located nearly 4 billion miles from the Sun.

2 **Pluto is approximately 4 billion miles from the Sun.**



© Y. Tabanés

In addition to its nine planets and their moons, the solar system is made up comets, thousands of asteroids, and innumerable meteorites.

Another way of measuring distance between the members of the Solar System is through astronomical units (AU).

One astronomical unit equals 92,955,800 miles (149,598,000 km), and represents the distance between the Sun and Earth.

The Planets

The nine planets can be divided into two main categories: terrestrial and Jovian. The four planets closest to the Sun—Mercury, Venus, Earth, and Mars—make up the terrestrial planets. The Jovian planets are the next farthest from the Sun and are called Jupiter, Saturn, Uranus, and Neptune. These planets are much larger than the terrestrial ones and are gaseous. The farthest planet from the Sun, Pluto, is neither terrestrial nor Jovian, and perhaps resembles an icy satellite more than it does a real planet.

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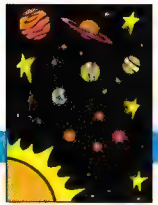
What are quasars?



THE UNIVERSE

1. Mysterious faraway galaxies
2. Hi-tech electronic equipment
3. Large areas of quicksand

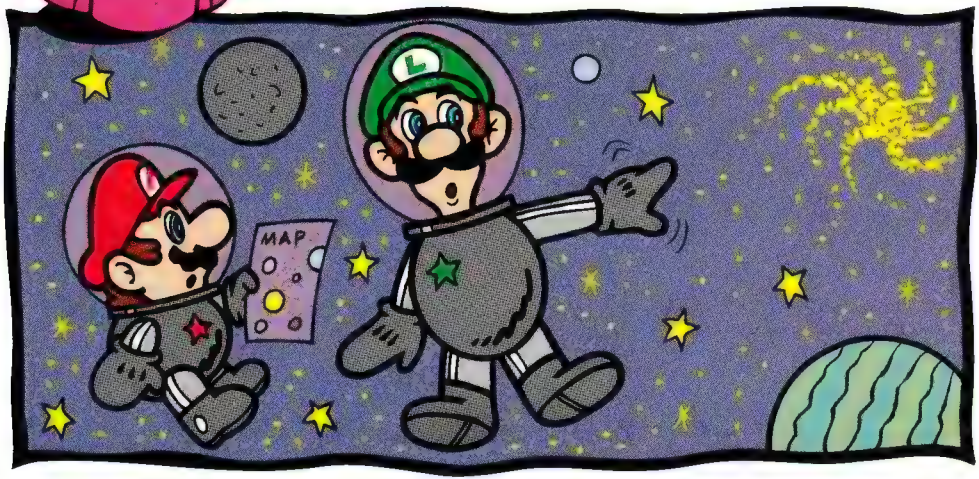


Illustration: Gary Fields

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Quasars

The strangest galaxies known are the far-off objects called quasars. They cannot be seen in detail, but they seem to be sending out huge amounts of energy from a small area of space near their center.

1 Quasars are faraway galaxies about which relatively little is known.

© Science Source / Explorer

The brightest quasar is 3C 273, which is found 2 billion light-years from the Earth.

To understand the relatively small size of quasars, you need to know that distances in space are sometimes measured in light-years. A light-year is the distance light travels in a year, or roughly 5,880 billion miles. Quasars are only one or two light-years across, but they give off up to 1,000 times more light than gigantic galaxies that measure 100,000 light-years across! Quasars are so bright that they can be seen from more than 10 billion light-years away!

Why So Bright?

The enormous amount of light is released from a small area at the center of a quasar. Some scientists believe that this light is actually energy being released as gases are sucked into a black hole. A black hole is an area in space where the gravitational pull is so great that even light cannot escape its force.

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Which constellation is used to locate the Polar Star?

THE UNIVERSE

1. The constellation Polar Bear
2. The constellation Polaris
3. The constellation Stella Axis

Illustration: Gary Fields

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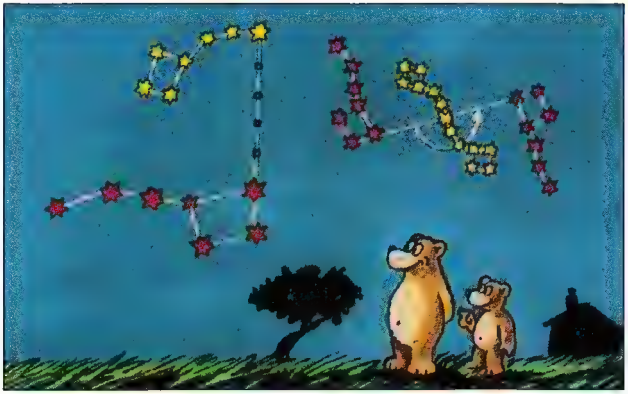
Polar Star

Ursa Major and Minor are known as the Big and Little Dippers. The North Star or Polar Star is at the tip of the Little Dipper's handle.

2 The constellation Polaris is used to locate the Polar Star.



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The Big Dipper and the Little Dipper.

Long before the invention of technological aids such as the compass or radar, Polaris—also called the North Star—was used as a reference point in navigation and travel. This is because it appeared to stay in a fixed position in the sky. We know, however, that the stars are always moving rapidly through space, whether we can easily see the movement or not.

Guiding Light

Polaris is about 680 light-years from Earth. A light-year is the distance a beam of light travels in one year—5.88 trillion miles (9.46 trillion km). In the United States, slaves escaping to freedom would "follow the drinking gourd" to the North—a reference to the Big Dipper, with the North Star above its outer rim. Some refer to the Big Dipper as a chariot. Our Galaxy, the Milky Way, has about 1,000 billion stars. Each star is made of hot gas.

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How big is Neptune?

THE UNIVERSE

1. Seventeen times smaller than Earth
2. The same size as Earth
3. More than seventeen times larger than Earth

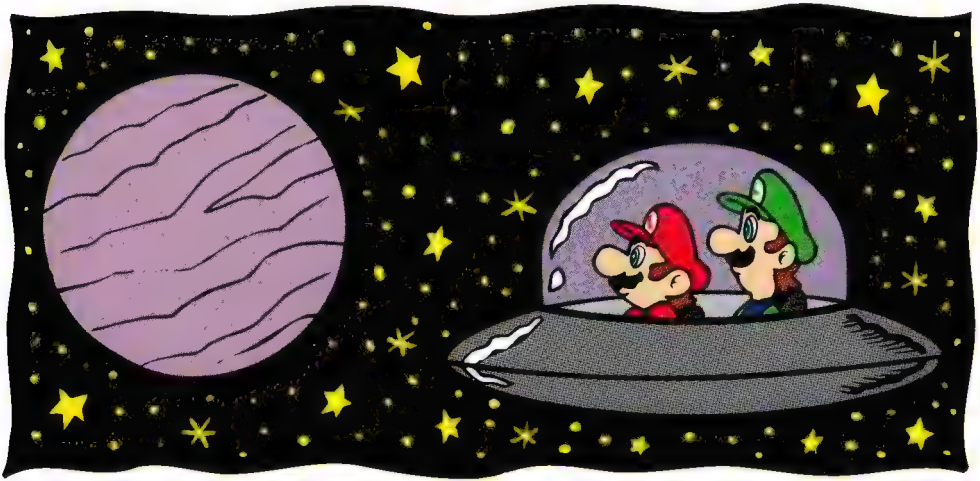

Illustration: Gary Fields

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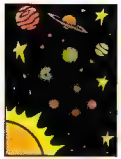
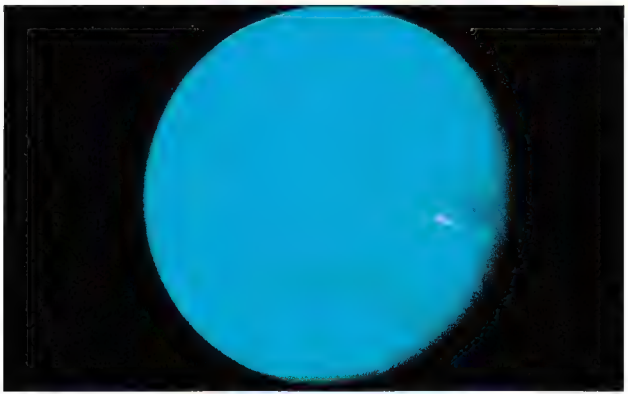
Neptune

Though Neptune was named for the Roman god of the sea, its clouds do not contain water, but methane, a gas found in its atmosphere. Its equatorial diameter is 30,800 miles (49,560 km), while that of Earth is 7,927 miles (12,757 km).

3 Neptune's mass is more than seventeen times larger than that of Earth.





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The diameter of Neptune's equator is nearly four times greater than that of Earth.

Neptune, the eighth major planet from the Sun in our solar system, was discovered in 1846. Its deep blue color may seem inviting, but Neptune is a cold planet made of ice, rocks, and gas such as hydrogen, helium, and methane. Neptune's temperature is at least -378°F (-21°C). The planet is so cold because it is extremely far from the Sun (on average, about 2,794,000 miles (4,497,000 km) away. Some say that Neptune's core is cold, and some say it is hot like Earth's.

Ringed Planet

Like Saturn, Neptune is encircled by rings—at least four of them—and while Earth has only one natural satellite or moon, Neptune has at least eight moons.

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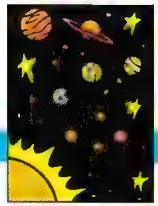
What is used to collect light in a telescope?



THE UNIVERSE

1. Reflective paint
2. Solar panels
3. Lenses and mirrors

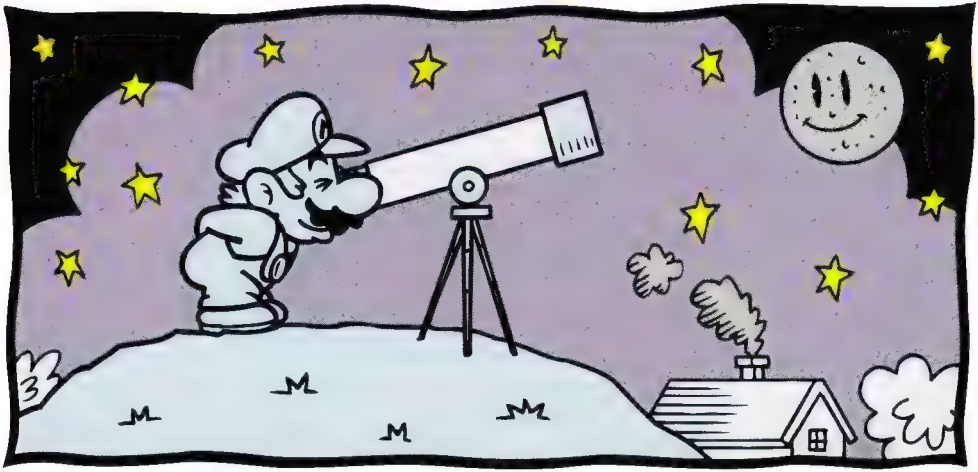


Illustration: Gary Fields

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Telescope

Telescopes use lenses and mirrors to collect light from an object, such as a star or distant planet. Telescopes bring the light into focus to create an image and then magnify the image, or make it bigger.

3 Light is collected in a telescope with lenses and mirrors.

© D. Palais / Spa Image

Some stars are so far away that they do not appear larger even when viewed through a telescope.

There are two main kinds of telescopes, refractors and reflectors. To bring light into focus, refractors use lenses, while reflectors use mirrors. Both kinds of telescopes have an eyepiece, or series of small lenses which magnifies the image. Refracting telescopes are most often used to study the Moon and the planets. Reflecting telescopes are used primarily to examine far away objects, including other galaxies.

The mirrors in early reflecting telescopes were made of a mixture of copper and tin and later, by depositing a film of silver on a glass surface. Today, longer lasting aluminum coating has replaced silver.

Telescopes Today

In the past century, several enormous reflecting telescopes have been constructed in mountainous areas with open views of the sky.

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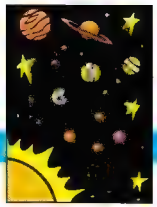
How long does it take Earth to orbit the Sun?



THE UNIVERSE

1. 100 days
2. 365.2564 days
3. 1,365 days

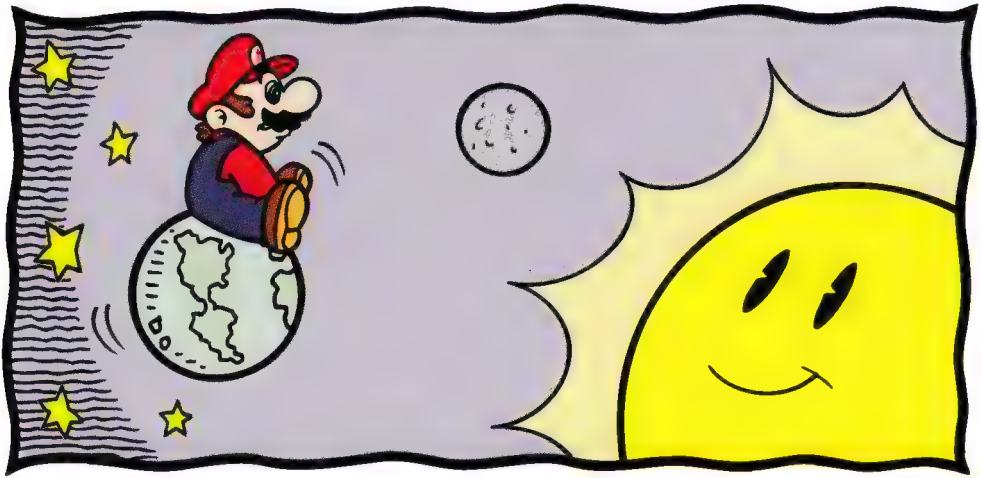


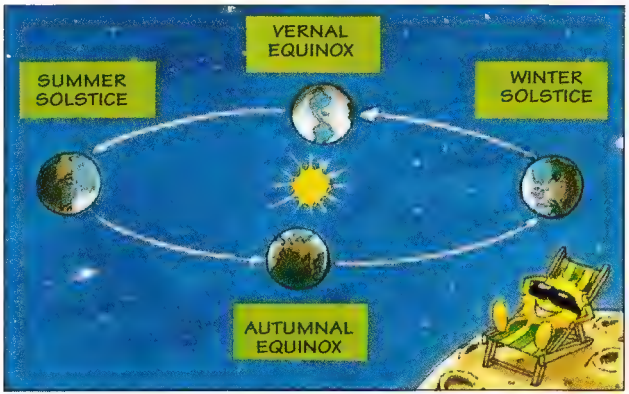
Illustration Gary Fields

©1996 Nintendo

Earth's Orbit

Since Earth takes slightly more than 365 days to orbit the Sun, we make up the difference by adding an extra day to February every 4 years and another extra day to the calendar every 100 years.

2 **It takes Earth exactly 365.2564 days to orbit the Sun.**



The seasons are a result of the position of Earth relative to the Sun. Pictured clockwise are the summer solstice, vernal (spring) equinox, winter solstice, and autumnal equinox.

The Earth travels around the sun at a rate of almost 19 miles per second (30 km/s). Seasonal changes in temperature are caused by Earth's orbit, because the side of our planet that is closest to the Sun will be the warmest. As Earth spins, its axis slowly rotates, taking far longer to rotate 360° than it does to revolve once around the Sun.

Elliptical Orbit

Earth stays about 93 million miles (150 million km) away from the Sun during its orbit, which is not perfectly round but instead shaped like an ellipse—slightly oval. Earth is tilted on its axis in such a way that the two poles have long periods of light and long periods of dark—up to six months of each at a time. The greatest total amount of sunlight falls on the midsection of Earth, the Equator.

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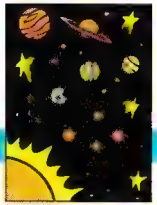
Are there volcanoes on the Moon?



THE UNIVERSE

1 Yes
2 No

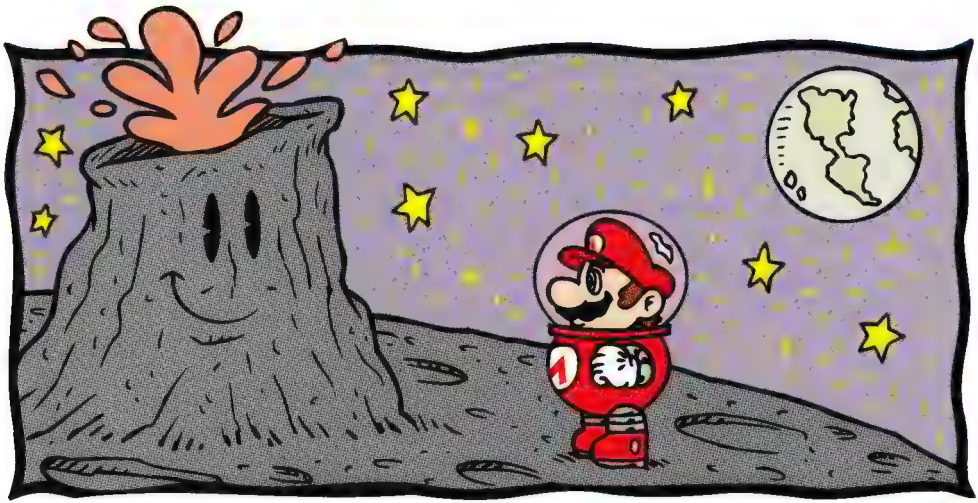


Illustration Gary Fields

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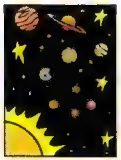
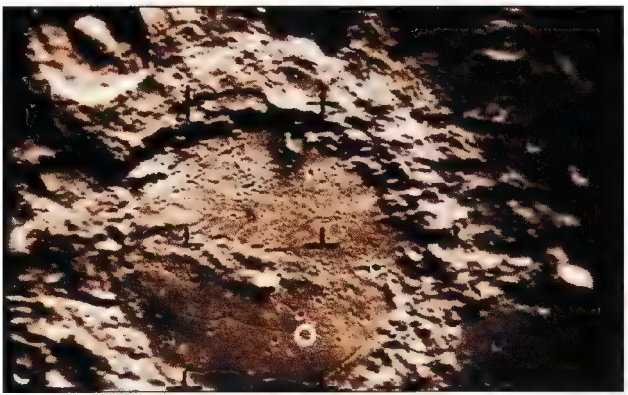
Moon

The side of the Moon that faces us was weakened by the pull of Earth's gravity. As a result, lava flowed out through cracks in the Moon's crust, flooding its older craters to form lava plains.

1 Yes, there are volcanoes on the Moon.





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The Moon gradually cooled, becoming rigid to at least 620 miles (1,000 km) down. There is no longer any volcanic activity.

The Moon is a fossilized world, where not much has happened during the last 3 billion years. But it has had a violent past. The Moon's surface is full of wide dents called craters, which were formed by comets. Comets are small chunks of rock and ice traveling through space, sometimes at speeds of 6 miles per second (10 km/s). When craters hit the Moon's surface at that speed, they exploded, leaving a crater about 10 times their own width.

Lava Plains

There was also volcanic activity on the Moon, due partly to the pull of Earth's mass. Hot lava bubbled up to the surface and filled many of the craters on the side visible from Earth. These lava plains are known as maria, the Latin word for "seas."

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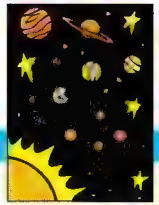
What is a comet?



THE UNIVERSE

1. A dead star
2. A large meteor
3. A lump of ice and rock

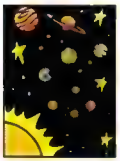
Illustration: Gary Fields

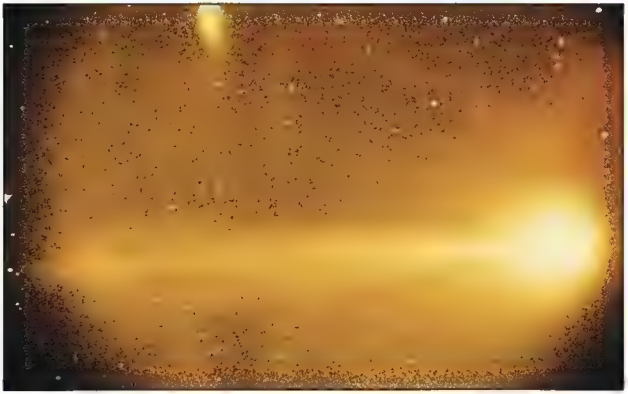
©1996 Nintendo

Comet

The Latin term for comet is *stella cometa*, or "hairy star," because a comet's long trail of gas and dust looks like a tail.

3 A comet is a lump of ice and rock.





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Comet Kobavashi-Berger-Milon showing its tail made of gas and dust.

As a comet nears the Sun, the ice melts, giving off jets of gas and releasing clouds of dusty rock particles. From Earth, this gas and dust looks like a long shining tail. The most famous comet is named after the man who first recognized that comets have regular orbits like other objects in space.

Halley's Comet

Thanks to Edmund Halley (1656-1742), an English scientist, we know that comets are controlled by gravity just like any other object in orbit. Halley figured out that comets seen in 1531, 1607, and 1682 were actually the same comet. He predicted that it would appear again in 1758, and a year after his death in 1757, he was proven right. Since his discovery, astronomers have concluded that sightings of Halley's Comet date back to 240 B.C.

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What is parallax?

THE UNIVERSE

1. A kind of dust found in space
2. A process which forms moons
3. The way stars seem to shift relative to Earth

Illustration Gary Fields

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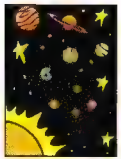
Moving Stars

Thanks to powerful telescopes developed during the 19th century, astronomers learned that not all stars are stationary. Some of them move at varying speeds, while others appear to change direction slightly.

3 Parallax is the way stars seem to shift in position relative to Earth.



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Early astronomers believed that all stars were fixed. They used stars as a reference point for measuring the movement of the planets, which they considered to be wandering stars.

Fixed stars remain stationary for their entire lives. Other stars actually move ever-so-slightly. A star's movement is measured in *seconds of arc*. One second of arc is about the size of a pinhead. This type of star movement is called proper motion.

Parallax

Another kind of star movement is called parallax. It is a result of Earth's orbit around the Sun, which makes stars appear to shift back and forth. By measuring a star's parallax, astronomers can find the actual distance of a star from Earth.

Over the past few decades, the parallaxes of several thousand stars have been determined. The closest, Proxima Centauri, is about 3.3 light-years away. Most of the measured stars are over 65 light-years away.

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Who was Johannes Kepler?

THE UNIVERSE

1. Famous astronomer
2. First person to set foot on the Moon
3. Inventor of the space probe

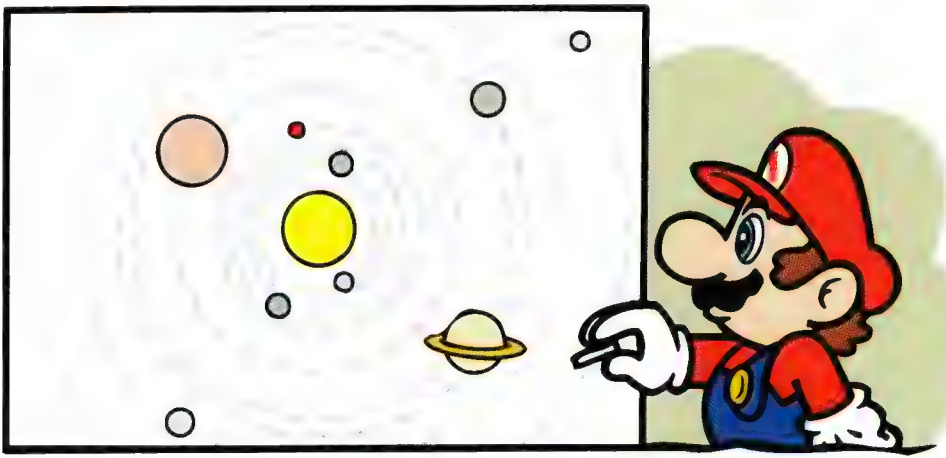

Illustration Gary Fields

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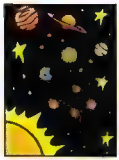
Johannes Kepler

Like other astronomers who accepted the heliocentric theory of the planets, Johannes Kepler believed that the Sun, not Earth, was the center of the solar system. During Kepler's time, many people believed the opposite.

1 Johannes Kepler was a famous German astronomer.



© Len Sirman

Kepler is one of the founders of modern astronomy. His writings were a major influence on other astronomers of his time.

One of primary works written by Johannes Kepler (1571-1630) was *Astronomia Nova (New Astronomy)*, published in 1609. In it, he discussed his efforts to calculate the orbital distance of Mars. He also mentioned two of his three Laws of Planetary Motion, which describe the structure of the solar system. First, the planets move in elliptical, or oval-shaped, orbits around the Sun. Second, the closer planets come to the Sun, the faster they move.

In 1619 Kepler published *Harmonice Mundi (Harmony of the World)*, in which he stated his third Law. This Law is a mathematical equation demonstrating that there is a relationship between the time it takes a planet to orbit the Sun—its orbital period—and the planet's distance from the Sun.

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What are radio telescopes used for?

THE UNIVERSE

1. Viewing very dim or distant objects
2. Sending messages through space
3. Tuning radios

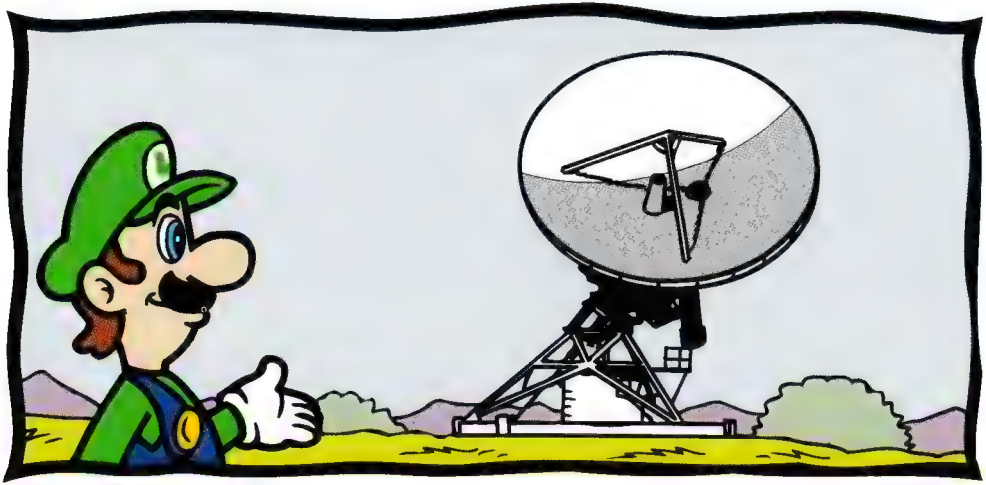

Illustration Gary Fields

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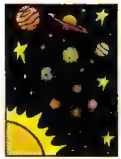
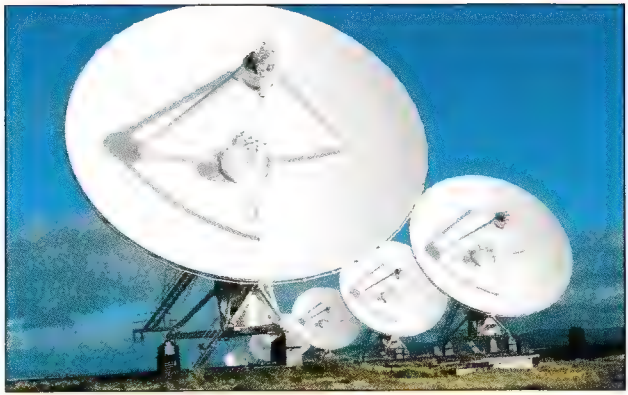
Radio Telescope

Many objects in space give off both light and invisible radio waves. These radio waves penetrate Earth's atmosphere and can be detected by radio telescopes.

1 Radio telescopes are used to view dim or distant objects in space.





© Galia / Jerrican

Most of the radio telescopes used today have a wide metal dish and a central antenna.

The first radio telescopes were not fancy. They consisted of a series of wires and poles. Simple metal bars were used as an antenna to receive radio waves.

Most modern radio telescopes have a concave dish that collects radio waves and reflects them onto an antenna. The antenna sends the signals to an amplifier, which makes the signals stronger. The signals are then sent to a computer to be processed and transformed into pictures.

Radio Telescope Observatories

The main radio telescope at the Parkes Observatory in Australia has a 210-foot (64 m) dish. The Very Large Array (VLA) at the National Radio Astronomy Observatory in Socorro, New Mexico, is a series of 27 antennas, each with dishes 82 feet (25 m) wide. The 330-foot (101 m) dish in Effelsberg, Germany, is the largest steerable radio telescope.

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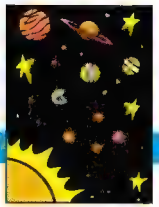
What happens during a lunar eclipse?



THE UNIVERSE

1. The Sun passes into Earth's shadow.
2. The Moon passes into Earth's shadow.
3. The Sun passes into the Moon's shadow.

Illustration: Gary Fields

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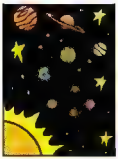
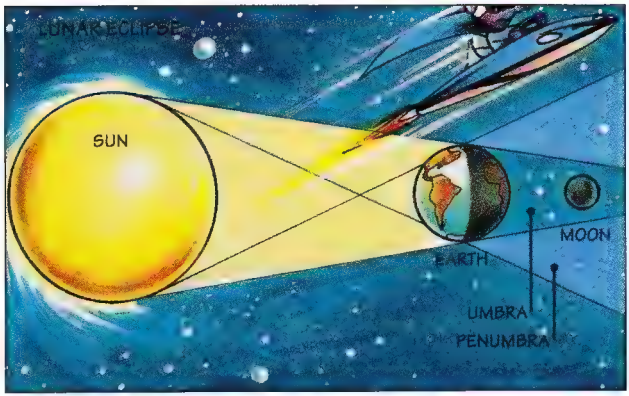
Lunar Eclipse

Earth casts a shadow when the Sun shines on it. A lunar eclipse occurs when the Moon passes into Earth's cone-shaped shadow and is temporarily hidden from view.

2 A lunar eclipse occurs when the Moon passes into Earth's shadow.





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The illustration above shows the position of the Sun, Moon, and Earth during a lunar eclipse.

There is usually at least one lunar eclipse each year. Lunar eclipses may be partial or total. A total eclipse occurs when the Moon passes completely into Earth's umbra, or shadow. The closer the Moon passes to the center of Earth's umbra, the longer the eclipse lasts.

A partial lunar eclipse occurs when only part of the Moon passes into Earth's umbra and is darkened, while the rest remains illuminated.

View from Earth

The Moon's surface becomes noticeably darker when it enters Earth's penumbra—the area of partial shadow surrounding the umbra. When the Moon enters Earth's umbra during a total eclipse, it may still be visible, although barely. If a lunar eclipse occurs when Earth is enveloped in a very heavy layer of clouds, no light is diffused into the umbra, and the Moon is invisible.

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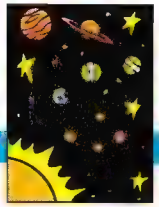
What is a space probe?



THE UNIVERSE

1. Manned craft exploring Earth's atmosphere
2. Solar-powered lunar vehicle
3. Spacecraft used to explore the solar system

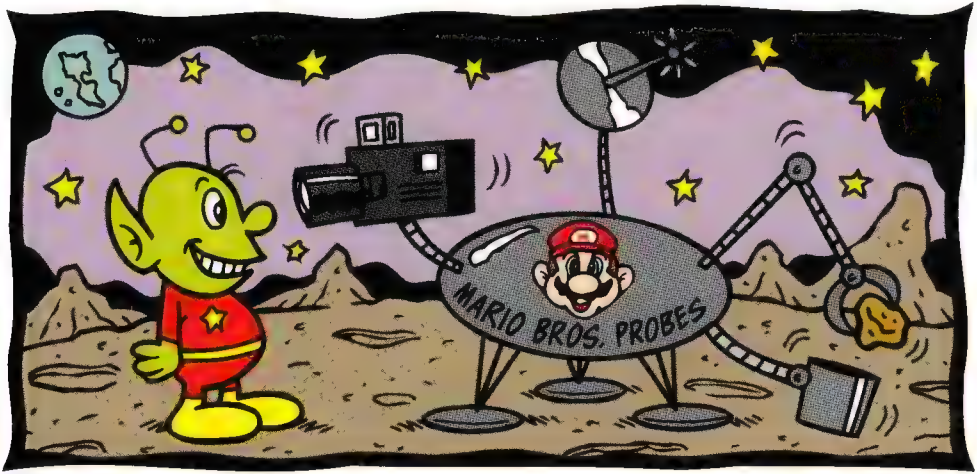


Illustration Gary Fields

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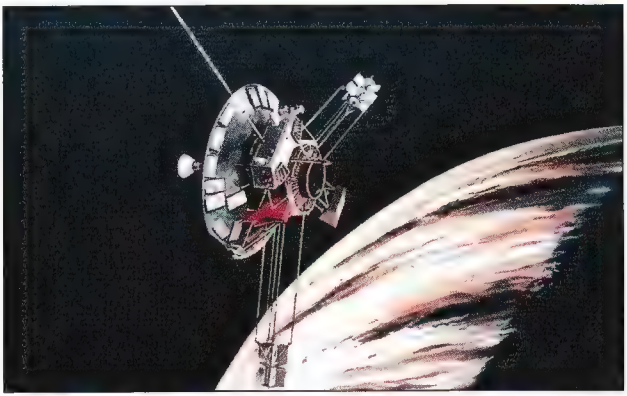
Space Probe

Space probes do not carry people. Equipped with scientific instruments, space probes work automatically, like robots, to gather information about objects in the solar system.

3 A space probe is a type of spacecraft used for exploring the solar system.



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In 1973, American space probe Pioneer 10 reached Jupiter. Since the first successful space probes explored the Moon, probes have visited every planet in the solar system except Pluto.

On February 3, 1966, the Soviet space probe *Luna 9* became the first to make a successful soft landing on the Moon. It transmitted back to Earth the first pictures of the Moon's surface.

The former Soviet Union was also the first nation to send unmanned space vehicles to the Moon. The *Lunokhods*, sent in 1937 and 1979, were controlled by radio from Earth—they traveled over the Moon's surface taking pictures and collecting data.

Probing Planets

On December 14, 1962, the American probe *Mariner 2* flew past Venus and measured the temperature of its atmosphere. In 1974, *Mariner 10* flew by Venus and then Mercury.

Mariner 9 and *Viking 1* visited Mars in 1971 and 1976, respectively. In 1991, the American probe *Galileo* examined the asteroid Gaspra.

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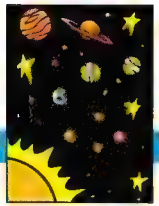
What was the first animal sent into space?



THE UNIVERSE

1 Dog

2 Rabbit

3 Monkey

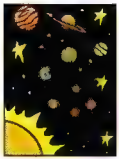
Illustration Gary Fields

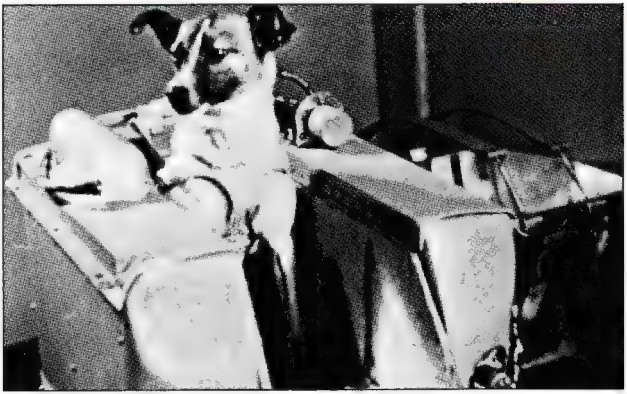
©1996 Nintendo

Laika

Although Laika died after seven days in space, her trip proved that a living being could survive weightlessness. Laika's trip paved the way for human space travel.

1 The dog Laika was the first animal sent into space.





© Agence Tass

Inside Laika's satellite were two containers that supplied the air and food she needed to survive in space.

A satellite is any object that orbits a celestial body. For example, the Moon is a satellite of Earth. The first successful artificial satellite, *Sputnik 1*, was launched by the former Soviet Union in October 1957. It was an aluminum globe weighing 184 pounds (83 kg). It orbited Earth for 57 days, collecting data on cosmic rays, meteoroids, and the temperature and density of Earth's atmosphere.

Dog in Space

The Soviet satellite *Sputnik 2* was the second successful satellite. It went into orbit on November 3, 1957, carrying a dog named Laika. *Sputnik 2* transmitted back to Earth information on how Laika's body reacted to being in space.

The United States launched its first Earth satellite, *Explorer 1*, from Cape Canaveral, Florida, on January 31, 1958.

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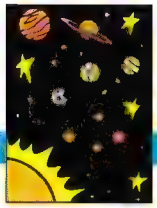
What is a space station?



THE UNIVERSE

1. A telescope used to photograph space
2. Manned satellite used for scientific observation
3. Place where rockets are built

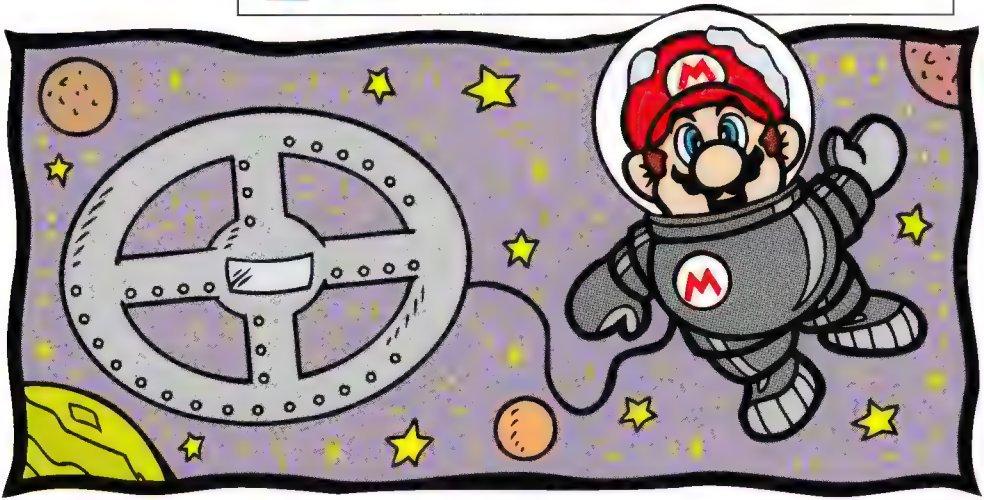


Illustration: Gary Fields

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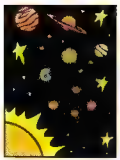
Space Station

A space station is like a floating science laboratory. Space stations may also serve as refueling stops for spacecraft or as launching sites for missiles and satellites.

2 **A space station is a manned satellite used to conduct scientific experiments.**



© Taunturer / Jerrican

Studies of how weightlessness affects humans are performed in space stations. The information gathered is used in planning future space flights.

The first attempt to launch a space station was made on April 19, 1971 by the former Soviet Union. Although it was designed for permanent orbit around Earth, *Salyut 1* re-entered Earth's atmosphere within six months.

Successful Launches

On May 14, 1973, the United States launched *Skylab,* the first successful space station. Three separate flight crews worked on board for 171 days, performing a variety of scientific studies. In July 1979, *Skylab* re-entered Earth's atmosphere and disintegrated.

The Soviets launched and successfully orbited 5 additional smaller *Salyut* space stations. Different crews worked on board *Salyut 6* for a total of 676 days, performing biomedical analyses and other scientific work. *Salyut 6* re-entered Earth's atmosphere in 1982.

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Do Martians exist?

THE UNIVERSE

1. Yes, they have been observed in flying saucers.
2. No, they are imaginary creatures.

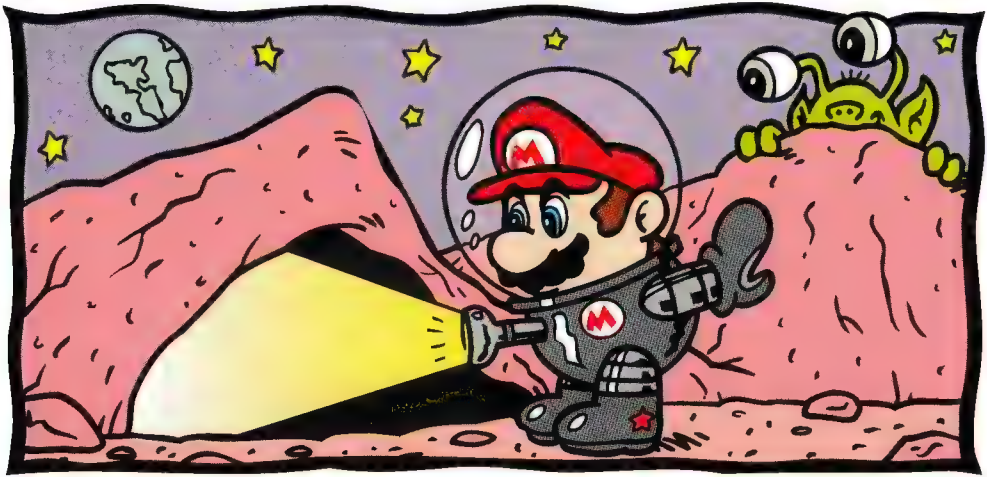

Illustration: Gary Fields

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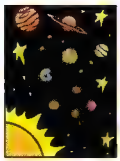
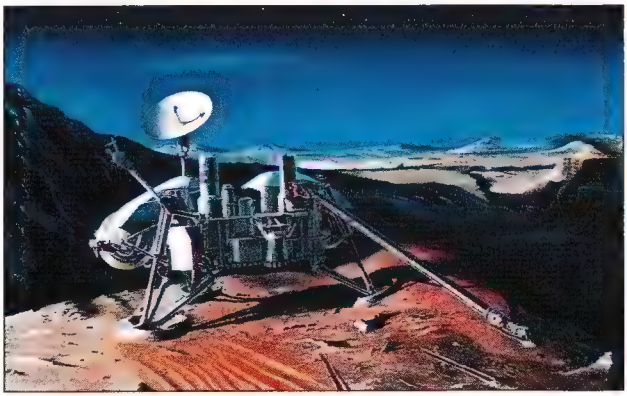
Martians

In 1877, Italian astronomer Giovanni Schiaparelli claimed he had seen a system of channels on Mars. American astronomer Percival Lowell speculated that these channels were part of an irrigation system built by Martians.

2 No, Martians are imaginary creatures.





© Viking / Galaxy Contact

In 1976, two American *Viking* spacecrafts landed on Mars and conducted observations of the planet's surface and atmosphere.

From 1960 to 1980, space probes from the United States and the former Soviet Union explored Mars. On December 2, 1971, the Soviet probe Mars 3 became the first to successfully soft-land an instrumented capsule on Mars.

Pictures taken by American probe *Mariner 9,* launched in November 1971, showed that Mars had a history of volcanic activity and erosion by ancient rivers.

Search for Life

None of the explorations yielded evidence of life on Mars. It was discovered that there are no canals on Mars. In addition, dark areas that were thought to be oases are not green. Seasonal changes in the planet's appearance are due to winds blowing sand and dust. Mars's thin atmosphere lets in too much harmful ultraviolet light from the Sun for life to exist.

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What is a pulsar?

THE UNIVERSE

1. Star that emits pulses of radio waves
2. Very bright, young star
3. Distant constellation

Illustration: Gary Fields

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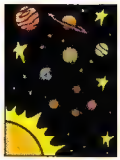
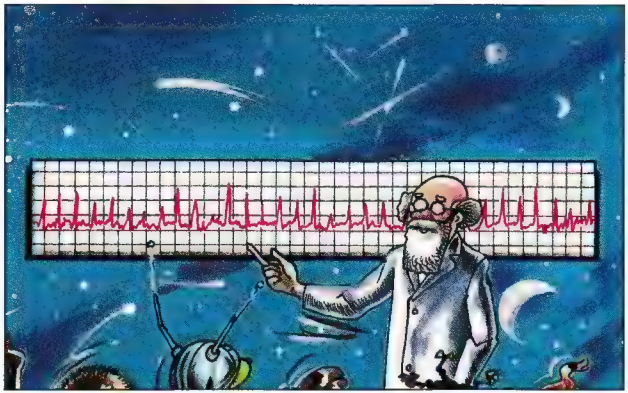
Pulsar

Pulsars are extremely dense, rapidly spinning neutron stars. Their powerful magnetic fields emit light and radio waves in beams of energy as the stars turn.

1 Pulsars are stars that emit pulses of radio waves.





© Y. Tabarés

The radio waves emitted by pulsars are very regular.

Pulsars were first discovered by chance in 1967, when astronomers Antony Hewish and Jocelyn Belle were testing a new telescope in Cambridge, England. The telescope detected bursts of radiation that repeated every few seconds. Before astronomers realized they had discovered a new kind of star, they thought these pulses of radiation were a message from extraterrestrials.

Life of a Pulsar

Pulsars are neutron stars, formed when the center of an exploding star called a supernova collapses inward to form a dense core. Pulsars have a diameter measuring 12 miles (20 km) or less. Each pulsar sends out pulses of radiation at a different speed. The slowest known pulsar emits beams of radiation every four seconds. The fastest rotates 642 times per second. Over the course of their lifetime, pulsars gradually slow down, at an average rate of one millionth of a second per year.

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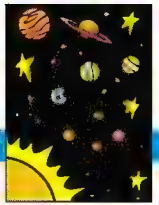
In which direction does the Sun rise?



THE UNIVERSE

1. North
2. South
3. East

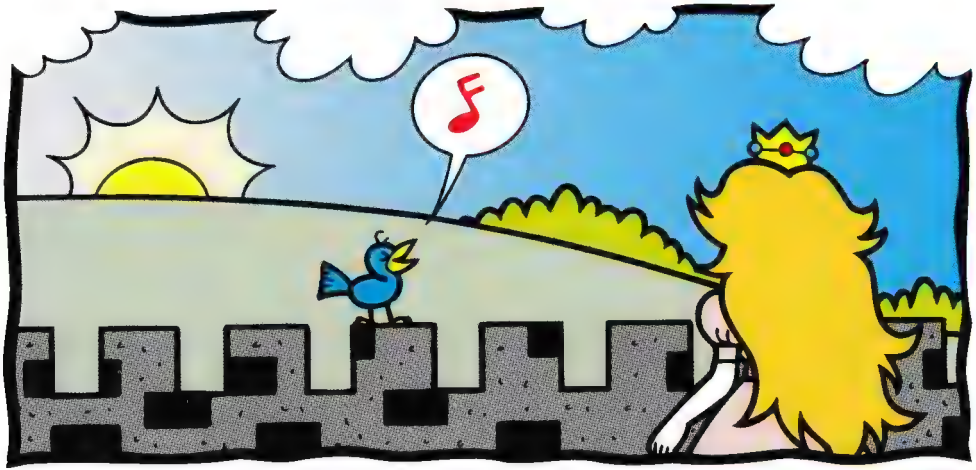


Illustration: Gary Fields

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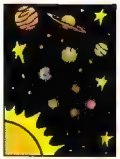
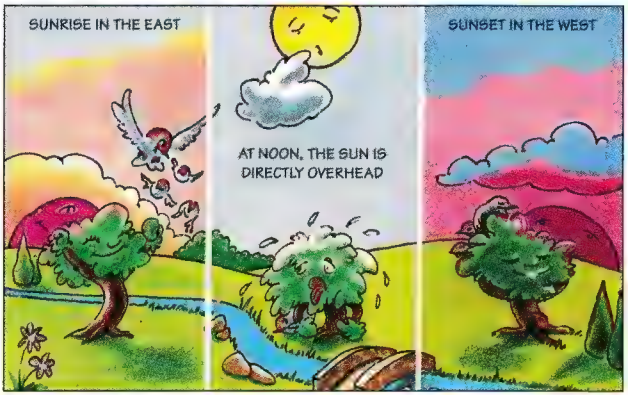
Sunrise

Every day, the Sun makes a great arc across the sky, rising in the east and setting in the west. But the Sun never moves! So how is this possible?

3 Every day, the Sun rises in the east.





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Because Earth always turns in the same direction, the Sun always rises in the east and sets in the west.

From our position on Earth, the Sun appears to be moving, but it's actually Earth itself changing its position in relation to the Sun. Imagine Earth as a ball with a line drawn through its center from North Pole to South Pole. This imaginary line is Earth's axis. As Earth spins on its axis, different parts of the planet move toward and away from the Sun.

Sunrise, Sunset

As your house—your spot on the planet—turns toward the Sun, the Sun becomes visible at a point in the distance called the horizon. It almost seems to peek up over the horizon. As Earth continues to turn, the Sun becomes more visible. It seems to rise up into the sky. At noon, when your spot on the planet is directly facing the Sun, the Sun appears to be directly overhead. In the afternoon, Earth continues to turn you away from the Sun, until the Sun sets, or disappears below the horizon.

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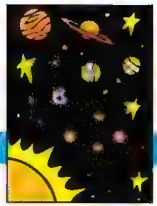
What are the light spots on the moon?



THE UNIVERSE

1. Highlands
2. Craters
3. Rivers

Illustration: Gary Fields

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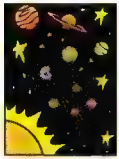
Lunar Highlands

Elevated areas, or highlands, of the moon reflect more light than lowlands do. This makes highlands appear brighter.

1 **From Earth, the highlands on the moon look lighter than the rest of the moon's surface.**



© Animals Animals / Sunset

Bright spots on the moon are highlands or mountains. Some were formed when meteors crashed into the moon. Others are the result of volcanic activity, just like mountains on Earth.

When you look at a full moon you can see its surface has light and dark spots. The dark spots are maria or vast lava plains that cover most of the moon's near side. Mountains and highlands appear bright. Most of the moon's mountains and rocky highlands surround craters on the far side of the moon—the side we can't see from Earth. The southern part of the moon's near side also has highlands.

Mountains on the Moon

The moon's highlands were formed when the moon's craters were formed. About 3 billion years ago, the moon was bombarded with meteors that crashed into its surface making huge indentations. As part of the surface sunk in to form a crater, the area around it mounted up to form highlands. Many of the moon's mountain chains were formed this way. Others are the result of volcanic activity, just like mountains on Earth.

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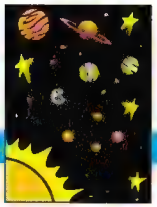
What did Isaac Newton discover when the apple fell?



THE UNIVERSE

1. The theory of relativity
2. The concept of universal gravitation
3. The recipe for applesauce

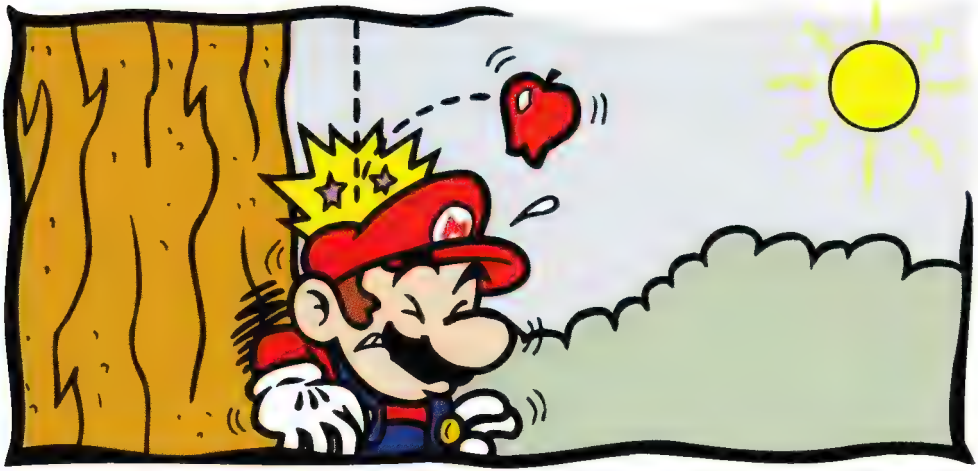


Illustration Gary Fields

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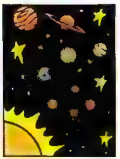
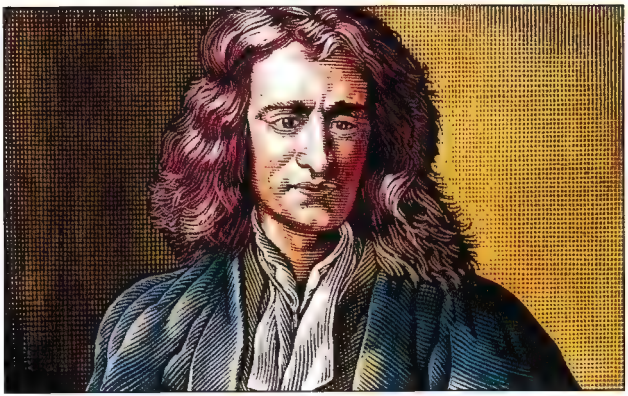
Isaac Newton

Sitting under an apple tree at his mother's farm, Newton watched an apple fall. He began to wonder about the force that drew the apple to the ground.

2 Isaac Newton discovered the concept of universal gravitation.





© Len Sirman

The story of Newton and the apple is true. Newton himself admitted that one little apple falling from a tree started him thinking about a scientific theory that would change the world.

Isaac Newton (1642-1727) was one of the greatest minds in scientific history. Growing up in England, he wasn't a great student, but he loved mathematics.

Important Discoveries

Expanding on his college math studies, Newton developed a type of math known as calculus. He also proved that the white light of the sun is made of a spectrum of colored light rays. These discoveries made him famous.

About that Apple

Newton's greatest discovery was universal gravitation. Watching the apple fall made him think Earth exerted a force that drew the apple downward. Based on this theory, he determined the force reached all the way to the moon. Without this gravitational force, the moon would move in a straight line through space, not in its continuous path around Earth. Newton's idea was revolutionary because it meant that Earth and the universe interacted.

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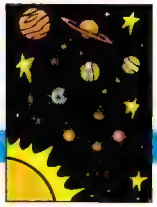
What is a supernova?



THE UNIVERSE

1. An exploding star
2. A type of spacecraft
3. An interplanetary

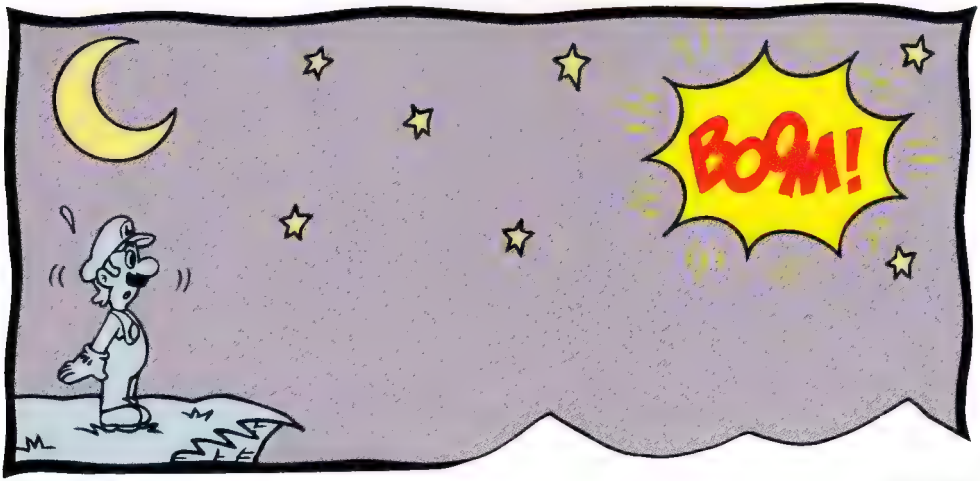


Illustration: Gary Fields

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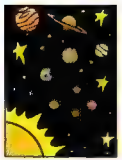
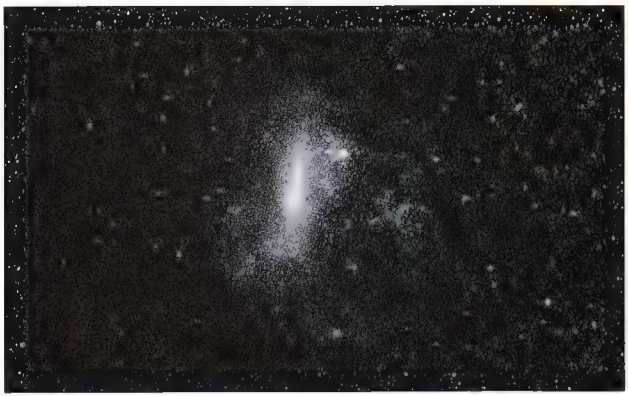
Supernova

Stars have life cycles during which they change and grow. At the end of their life cycles, some stars reach the supernova stage in which chemical changes cause them to explode.

1 A supernova is an exploding star.





© Galaxy Contact

The explosion of a supernova lasts just seconds; then the star gradually dims. The last supernova visible to the naked eye from Earth occurred in 1987.

Stars are burning balls of gases which produce the starlight we see from Earth. At its core, a star contains hydrogen gas, which it uses for fuel to keep the light burning. It may take a million years, but eventually, the hydrogen runs out and the star looks for other gases to consume as fuel.

The next gas it consumes is usually helium. This burns out faster than the hydrogen. It's all gone in about 700,000 years. In this way, the star consumes various gases as fuel. Each one burns for a shorter time than the one before it.

Core Collapse

The burning gases cause chemical changes in the star, which lead to the production of iron. But the star can't burn iron! When all the gases run out and the star is left with just an iron core, it explodes in a splash of light and shock waves. This is a supernova.

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What is a nebula?

THE UNIVERSE

1. A constellation in the galaxy Andromeda
2. An interstellar cloud
3. A creature from the planet Neb

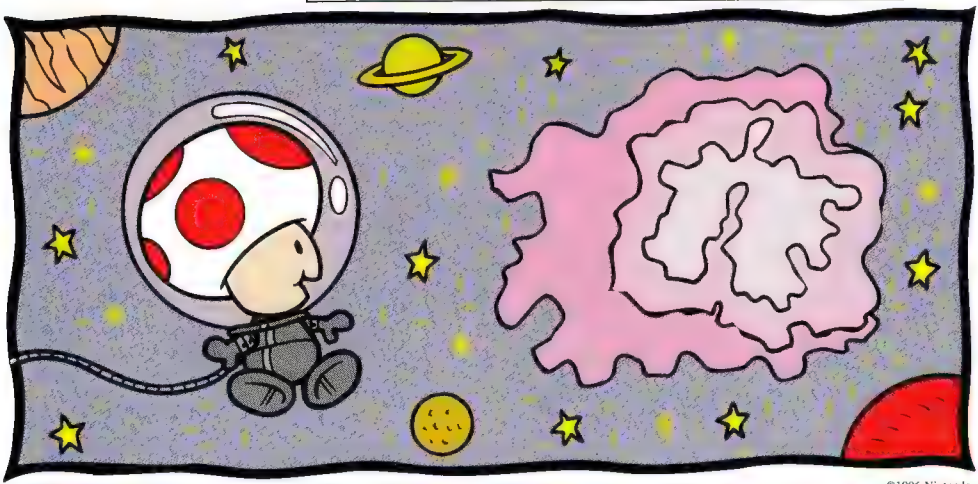

Illustration: Gary Fields

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Nebula

The term nebula was first used to describe fuzzy-looking objects in space. French astronomer Charles Messier started to catalog them in the 1700s.

2 A nebula is an interstellar cloud of dust and gas.

© Galaxy Contact

The Trifid Nebula appears to be red because of chemical reactions in the hydrogen gas they contain. Other nebulae, such as the Orion Nebula, look green because of the oxygen gas they contain.

The Messier Catalog of stellar bodies is still used by astronomers, though many of the nebulae he recorded have since been found to be galaxies or star clusters. Messier actually started to catalog nebulae after making some mistakes in his own astral research. What he *really* wanted to find were comets. After mistaking a few fuzzy-edged nebulae for streaking comets, he decided to record the positions of the nebulae so he wouldn't make the same mistake twice.

Bright and Dark

Nebulae may appear bright or dark. The two bright types are emission nebulae, which generate their own light, and reflection nebulae, which reflect light from nearby stars. Dark nebulae, also called absorption nebulae, look like dark blotches that block light from stars behind them.

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What are meteors?

THE UNIVERSE

1. Rocks from space
2. Shooting stars
3. Freeze-dried food for astronauts

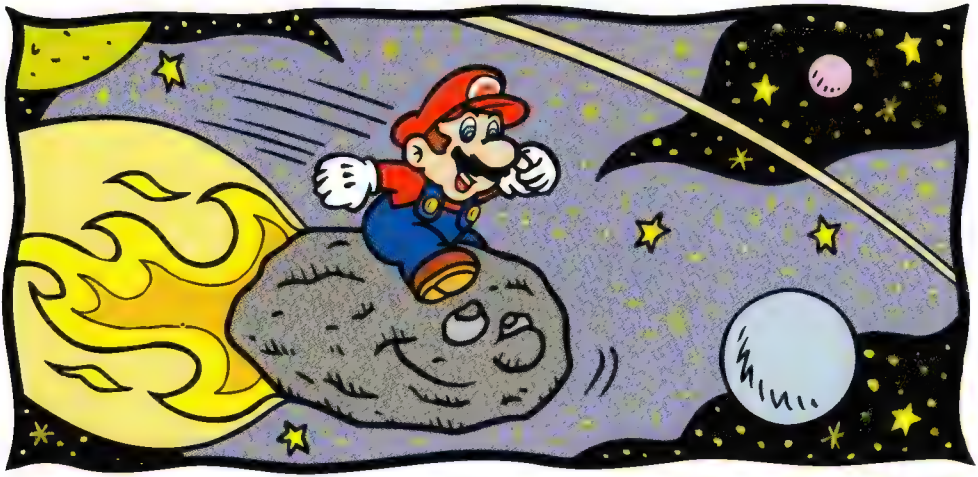

Illustration: Gary Fields

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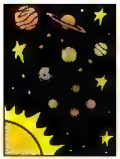
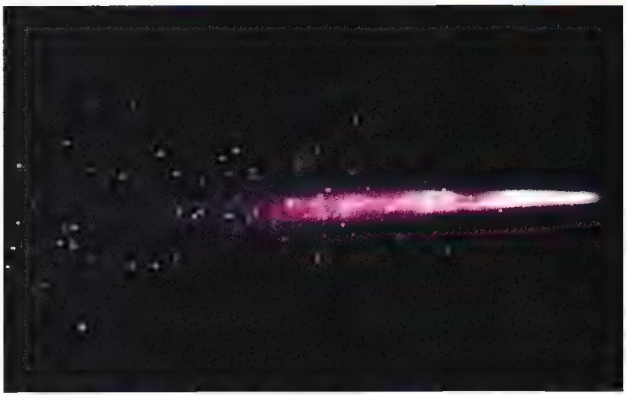
Meteors

A meteor is a shooting star formed from debris left by comets.

2 Meteors are shooting stars.





© Gamma

Meteors look like fireballs streaking through the sky. Because astronomers carefully track the paths of comets, and the dust they leave behind, they can predict when meteor showers will occur.

People often confuse meteors and meteorites, but they're two completely different things. Meteorites are space rocks that fall to Earth. Meteors are shooting stars that flash across the night sky.

Cosmic Dust

Even though meteors look large, they're actually formed from dust particles as tiny as a sesame seed. The particles come from cosmic debris scattered by comets as they orbit the Sun. Once they're deposited, the particles hang around in space. As Earth orbits the Sun, it passes by these particles. That's when things heat up!

Shower of Sparks

The dust particles—alone or in bunches—trickle down toward Earth's atmosphere. Friction caused by contact with the atmosphere causes them to burst into flame, and the sky looks like it's raining stars. This phenomenon is called a meteor shower.

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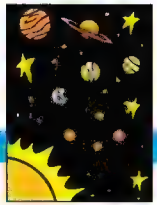
Can humans communicate with extraterrestrials?



THE UNIVERSE

1 Yes

2 No

3 Maybe

Illustration, Gary Fields

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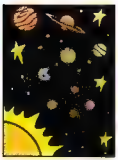
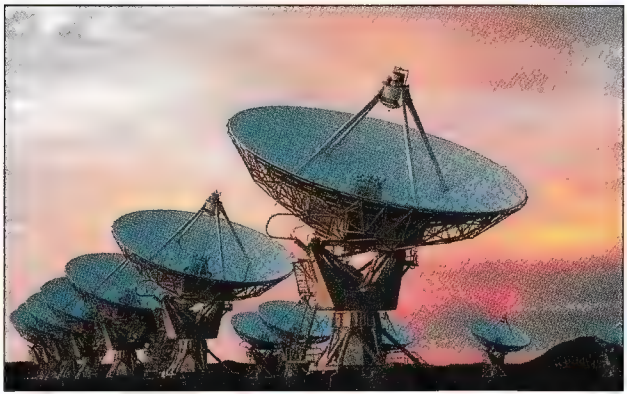
Radio Astronomy

Astronomers have attempted to communicate with civilizations that might live in other galaxies. So far they haven't received a response.

3 Humans might be able to communicate with extraterrestrials.





© R. Gaillarde / Gamma

Radio telescopes, like these, search the skies for signs of life in the universe. Occasionally, they send messages into space. So far, astronomers on Earth have received no response.

An optical telescope is fine for observing much of the activity in the universe, but astronomers use more powerful telescopes to detect objects that are too distant or dim for optical telescopes to detect. Huge, powerful radio telescopes find objects in the universe by detecting the radio or heat waves the objects emit. For example, since stars give off heat before they give off light, a radio telescope can find a new star even before it begins to shine.

What's the Frequency?

One of the world's largest radio telescopes is in Arecibo, Puerto Rico. From here, astronomers sent a radio message into space in 1974. The message was directed to a cluster of stars known as M13. It will arrive in about 25,000 years!

In 1977, space probes *Voyager 1* and *Voyager 2,* were launched. They also carry messages for extraterrestrials.

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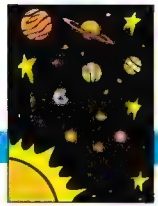
When did astronomers begin using telescopes?



THE UNIVERSE

1. 13th century
2. 15th century
3. 17th century

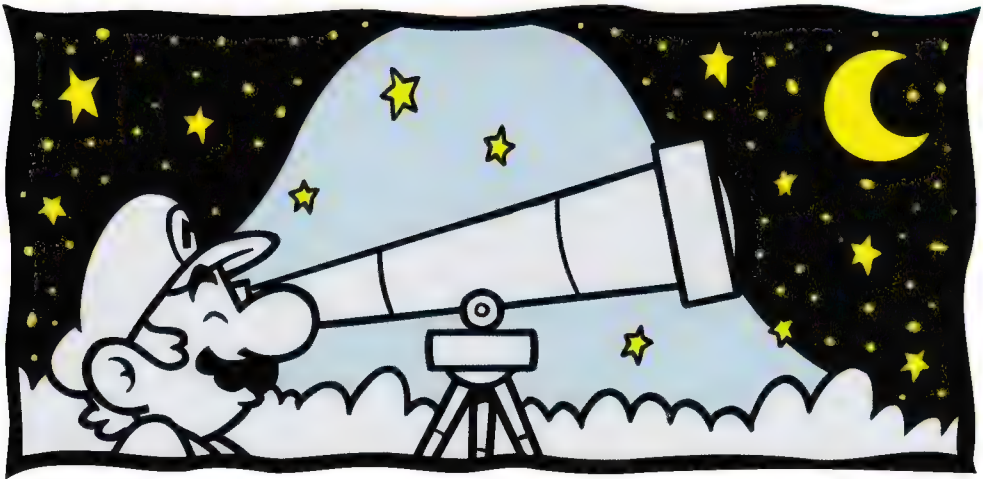


Illustration: Gary Fields

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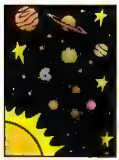
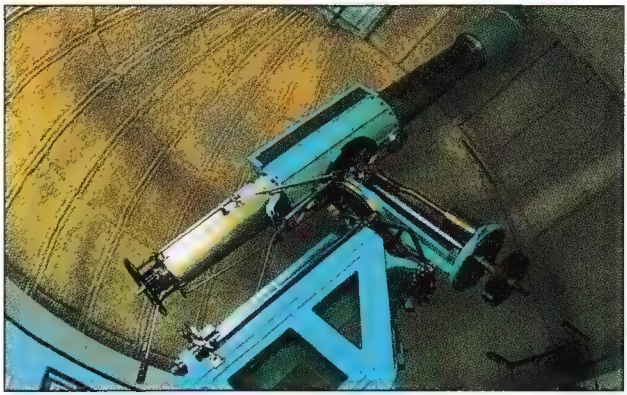
Telescope

A telescope magnifies the image of a distant object. The first telescope was invented by a Dutch optician named Hans Lippershey in 1608.

3 **Astronomers started using telescopes in the 17th century.**





© Len Stman

Astronomical observatories use huge telescopes to study the stars and planets.

Italian astronomer Galileo was the first to use a telescope to study stars and planets. He discovered the moons of Jupiter and the rings of Saturn.

Ever since Galileo trained his telescope on the heavens in 1609, the telescope has been a vital part of every astronomer's equipment. Dozens of great astronomers and physicists contributed to the development of the telescope—Isaac Newton and Johannes Kepler among them.

Two Types

The two main types of telescopes are refractors and reflectors. The difference between them is what happens to light when it enters the telescope. A reflector contains one or more mirrors that reflect the light from a distant object and bring it into focus. A refractor uses glass lenses to collect and filter light from a distant object so it becomes visible to the naked eye.

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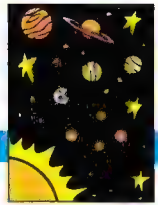
Who were history's first astronomers?



THE UNIVERSE

1. Greeks
2. Bantu
3. Maori

Illustration: Gary Fields

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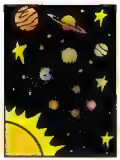
Astronomy

Ancient Greeks were the first to think of the universe as an interrelated system instead of a bunch of independent events. But they made one big mistake.

1 The ancient Greeks are considered to be history's first astronomers.



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Nicolaus Copernicus was eventually persuaded to publish his sun-centered theory of the universe. He did so in 1543, and, coincidentally, he died the same day.

In 260 BC, Greek astronomer Aristarchus suggested that Earth revolved around the sun. Others disagreed. They felt sure Earth was the center of the universe.

In 140 AD, Greek astronomer Claudius Ptolemy wrote a long treatise on the Earth-centered theory. He was wrong, but he was so sure he was right that everyone believed him. His theory held for over 1,000 years—until Copernicus came along.

Quiet Copernicus

Nicolaus Copernicus, a Catholic church official in Poland, proved that Aristarchus' original theory of a sun-centered universe was correct. But his views went against what everyone in the world thought was right. Copernicus could have been executed for his theory. By leaking his ideas to a few scientists, Copernicus started a new wave of astronomical study. Without him, we might still believe that the planets revolve around Earth!

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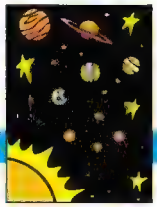
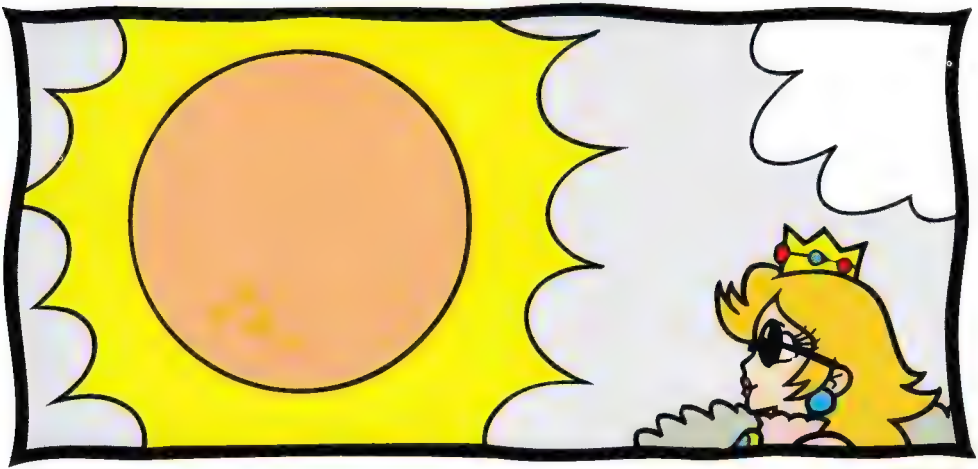
Why do sunspots appear to be dark?



THE UNIVERSE

1. They're in the shadow of the moon.
2. They're cooler than the sun's surface.
3. They are volcanic.



Illustration, Gary Fields

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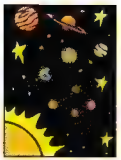
Sunspots

Sunspots occur in the sun's photosphere, the layer of the sun that we can see. They last for varying amounts of time—from a few hours to several months—and they occur in pairs.

2 Sunspots are slightly cooler than the sun's surface.



© Sanford / Science Photo Library / Cosmos

Sunspots look like black marks on the sun's surface. From Earth they look tiny, but they can be as small as 600 miles (1,000 km) across or larger than Earth itself.

Over time many theories have been proposed about the origins of sunspots. Today, astronomers believe that sunspots are caused by magnetic fields that prevent the sun's hot gases from rising to the photosphere. Sunspots generally occur 40 degrees north or south of the sun's central point, or equator.

Sunspot Cycle

An important discovery about sunspots was made in the 19th century when an astronomer found that sunspot activity occurs in cycles. Until that time, people believed sunspots were random events. Now we know sunspots follow an 11-year cycle. Eleven years pass between periods of maximum sunspot activity. When sunspots are at their peak the sun's power increases. This affects weather on Earth. Sunspots also have been linked to droughts, glacial activity, and patterns in tree rings.

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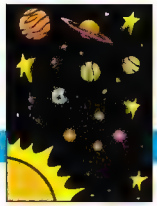
Which is a color radiated by stars?



THE UNIVERSE

1 Blue

2 Green

3 Stars have no color

Illustration: Gary Fields

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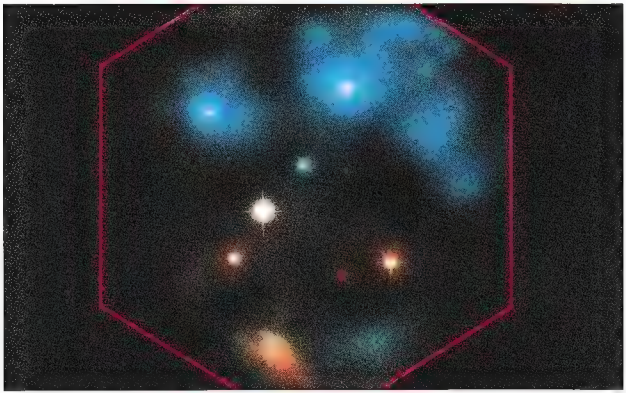
Star Colors

Stars radiate light in different colors depending mainly on their surface temperatures. Blue stars are the hottest and red are the coolest.

1 Some stars are blue.



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Using a telescope, astronomers can clearly see the colored light from various stars.

Of course, cool is a relative term. Even the coolest stars have surface temperatures of about 3,500K. (The Kelvin scale of temperature, abbreviated K, is used to measure surface temperature of stars.) The sun, a yellow star, had a surface temperature of about 6,000K. Blue stars have a surface temperature more than five times the temperature of the sun!

The Bigger They Are

In general, the hotter a star is, the brighter it appears. However, size is also a factor in a star's brightness. A red giant star appears much brighter than a white dwarf star, even though the white dwarf is much hotter.

Colorful Universe

The colors of some stars are visible to the naked eye. You can certainly see that the sun has a yellowish tint. Rigel, a star in the constellation Orion, is blue. Betelgeuse is red.

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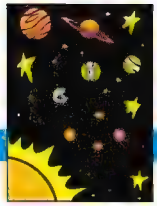
What is a solar flare?



THE UNIVERSE

1. Another name for an eclipse
2. An unidentified object that orbits the sun
3. A brightening of the sun's corona

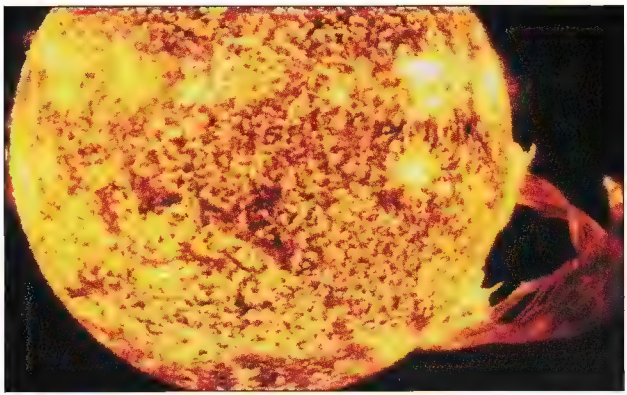
Illustration: Gary Fields

©1997 Nintendo

Solar Flare

The corona is the sun's outer layer. It's composed of gases and radioactive particles. A solar flare is a sort of explosion that occurs in the corona.

3 A solar flare is a brightening of the sun's corona.



© Gamma

Astronomers have not yet determined the cause of solar flares, or why they occur when they do. It has been found, however, that solar flares occur mainly in areas of the sun that have strong magnetic fields.

A solar flare releases a burst of energy in the form of heat, charged particles, and radio waves. This energy travels toward Earth. Fast moving particles reach Earth in as little as half an hour. Slower moving particles may take a day or two to reach Earth.

A solar flare only lasts for a few minutes and it's usually not visible to the naked eye. Yet its effects are felt on Earth.

Beautiful Disturbance

Solar flares can cause sudden temporary disruption in radio transmission on Earth. They also are responsible for an astonishing natural phenomenon called an auroral event. When the charged particles from the flare scatter into Earth's magnetic field they produce a display of colored light in the sky. One such event, the Aurora Borealis or Northern Lights, occurs in regions near the North Pole.

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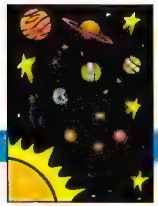
Which planet has a prominent magnetic field?



THE UNIVERSE

1. Earth
2. Mars
3. Venus

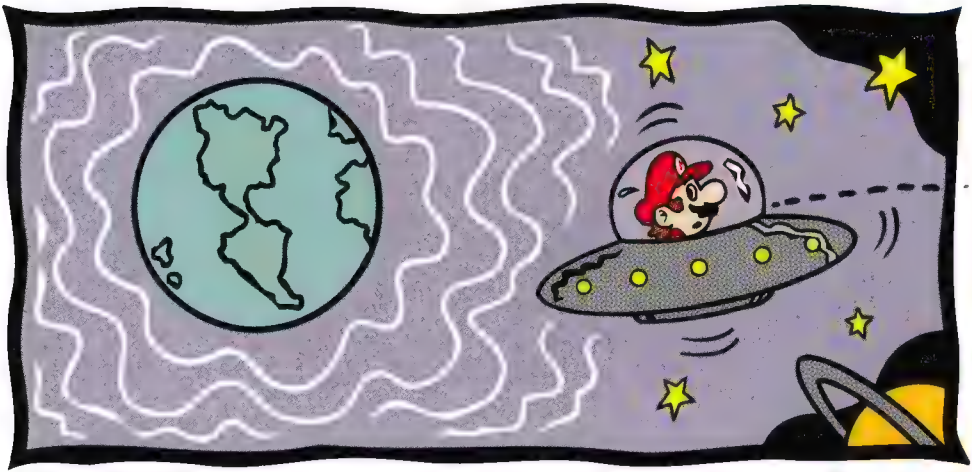


Illustration: Gary Fields

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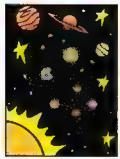
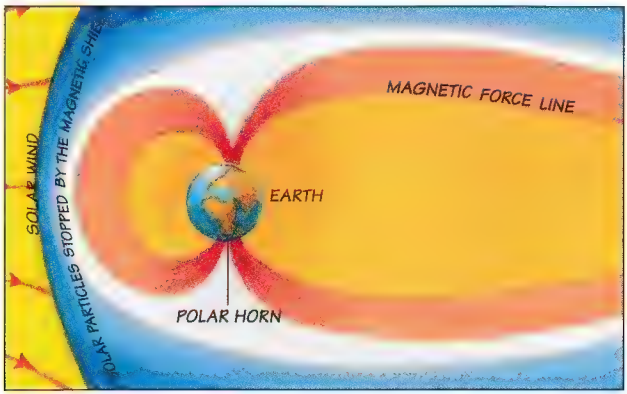
Magnetosphere

The magnetic field surrounding Earth is known as the magnetosphere.

1 Earth has a prominent magnetic field.





© Y Tabarés

Solar winds bend Earth's magnetosphere so it's smaller on the near side and larger on the far side. The magnetosphere keeps charged particles from the sun away from Earth. A few solar particles can reach Earth at the polar horns, above the North and South Poles.

Earth's magnetosphere is created by movement of molten iron in Earth's core. Waves, or currents, in the liquid iron, produce an electrical charge and a magnetic force. The force radiates from beneath Earth's surface to the outer layers of Earth's atmosphere, where it forms a magnetic field.

Without the magnetosphere, Earth would be bombarded by charged particles from the sun. The magnetosphere protects Earth by trapping the particles and forcing them into areas of swirling force known as Van Allen belts.

Other planets have magnetic fields, too. Venus has a very weak magnetic field. Jupiter and Saturn have gigantic magnetic fields.

Blown by the Wind

Solar wind, which blows away from the sun, bends Earth's magnetosphere so that it's smaller on the side of Earth nearest the sun and much larger on the side of Earth that's farthest from the sun.

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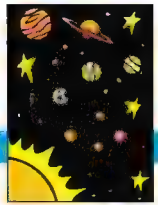
Why are some planets known as the outer planets?



THE UNIVERSE

1. Because of their colorful outer surfaces
2. Because they're made of gas
3. Because of their distance from the sun

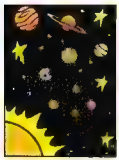
Illustration Gary Fields

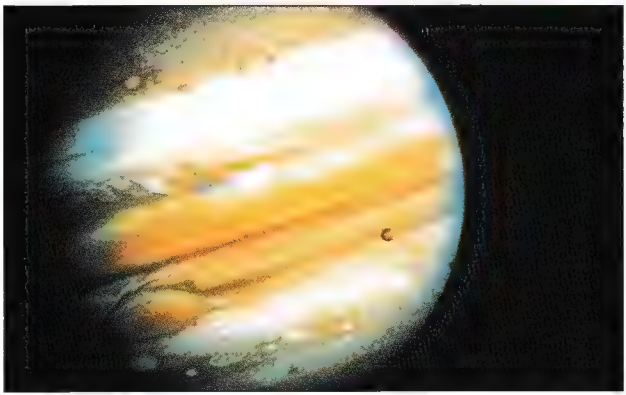
©1997 Nintendo

Outer Planets

Jupiter, Saturn, Uranus, Neptune, and Pluto are the outer planets. They are composed largely of hydrogen gas. Because they're so far from the sun they're very cold.

3 The outer planets are the ones farthest from the sun.





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Jupiter, the largest of the planets, is more than 400 million miles from the sun. It is one of the outer planets.

All the outer planets except Pluto are classified as giant planets because they are between 3.9 and 11.2 times the size of Earth. Pluto is smaller than Earth.

The rest of the planets—Mercury, Venus, Earth, and Mars—are known as the inner planets because they are closer to the sun. They are also known as terrestrial planets because they have rocky surfaces.

Dividing Line

The dividing line between the inner and outer planets is a huge gap—more than 300 million miles—in space between Mars and Jupiter. Within this space is a group, or belt, of asteroids known as the main belt. About 5,000 of the asteroids in the main belt have been tracked and there are about 13,000 more that have been identified. Most asteroids in the main belt orbit the sun just like the planets do.

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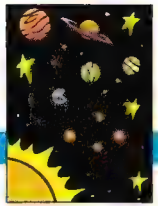
What is "My Very Elderly Mother Just Sat Upon Nine Pins"?



THE UNIVERSE

1. A code for communicating with martians
2. A saying to help remember the names of the planets
3. Classification of stars by size

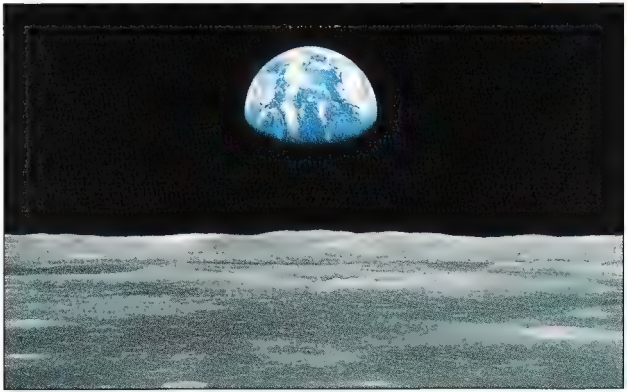
Illustration, Gary Fields

©1997 Nintendo

Inner Planets

The first letter of each word in the sentence, "My Very Elderly Mother Just Sat Upon Nine Pins," corresponds to the name of a planet. It begins with Mercury, the planet closest to the sun.

2 **The phrase helps you remember the order of the planets according to their distance from the sun.**



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Earth is one of the inner planets in our solar system. It is the third planet from the sun.

The order of the planets in terms of their distance from the sun is: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto.

Inner and Outer Planets

The four planets closest to the sun are known as the inner planets. They are relatively small and have rocky surfaces. They're very dense or heavy. Mercury, for example, is composed almost entirely of metal. The rest are known as the outer planets. All except Pluto are much larger than the inner planets. The outer planets are composed of gases. Jupiter, for example, has no physical characteristics such as mountains or craters. Its surface is made of gas.

In between the inner and outer planets—between the orbits of Mars and Jupiter—is a group of tens of thousands of space rocks known as asteroids.

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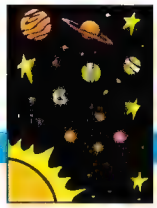
Can people use the sun's energy to heat their homes?



THE UNIVERSE

1 Yes

2 No

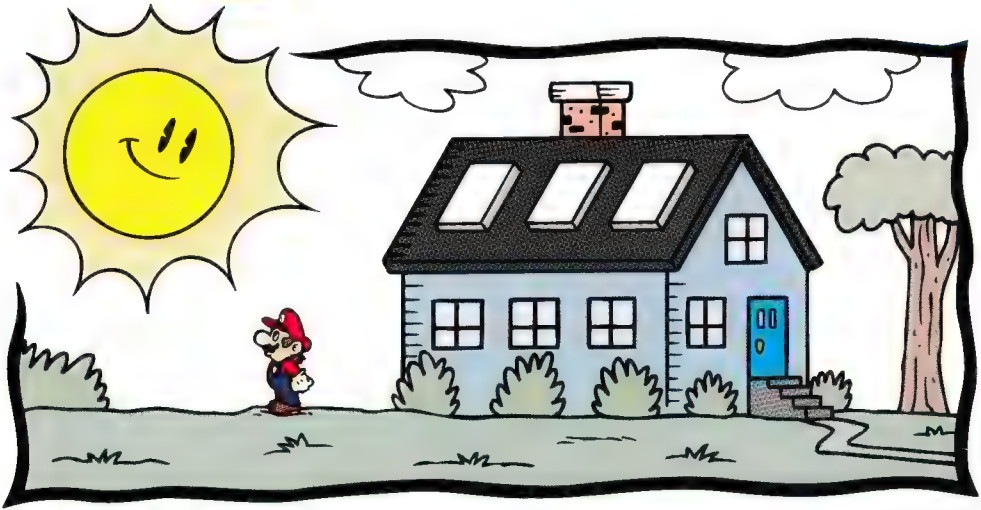


Illustration: Gary Fields

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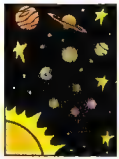
Solar Heating

You can recognize a building with solar heating by the large solar collector panels on the roof.

1 **Yes, people use solar energy to heat their homes.**



© STF / Sunset

Buildings that utilize solar energy for heating usually have many south-facing windows and a lot of solar collector panels mounted on the roof.

Solar collectors look like flat boxes, covered with several layers of plastic or glass. Beneath the clear glass or plastic is a layer of black material, usually metal or plastic. It's black because black absorbs heat better than any other color. When sunlight strikes the black plate, its heat is absorbed.

Water Works

Below the black plate is a system of copper tubes containing fluid. The heat from the black plate warms the fluid in the tubes. The warmed fluid flows to a heat exchanger where it heats a tank of water. The heated water is then pumped through pipes to heat the house, or it's used to feed the faucets in the house.

In very warm and sunny regions, some homes have solar water heaters outside the building. These heaters are basically insulated water tanks which absorb the sun's heat and hold it to keep the water hot.

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Is is possible to count the stars in the sky?

THE UNIVERSE

1 No, it's impossible.

2 Yes, astronomers have counted stars.

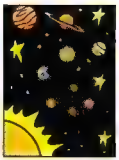
Illustration Gary Fields

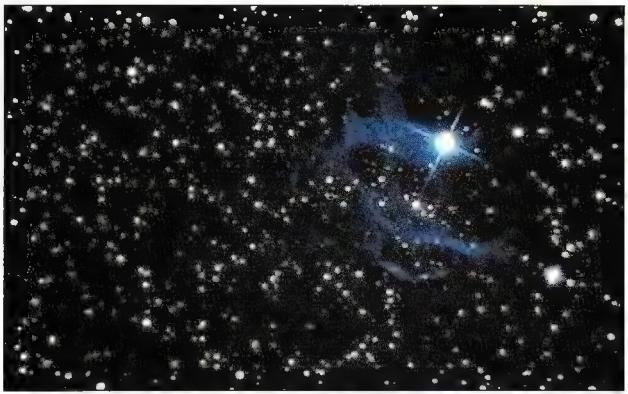
©1997 Nintendo

Star Gauges

In the 1780s, astronomer William Herschel successfully attempted to count the stars in a specific region of the sky. This marked the first time anyone had systematically counted stars.

2 Astronomers have successfully counted stars.





© DR / Gamma

It's hard to count the number of stars in this photo. Imagine trying to count all the stars in the sky!

Herschel was mainly interested in concentrations of stars in particular areas of the sky. So, he trained his telescope on a limited area and he counted. He didn't count every single star. He made sample counts and used them as a basis to estimate a concentration of stars in a given region. These counts are known as star gauges. Herschel made them for most of the northern hemisphere. His son John continued his work in the southern hemisphere.

Billions and Billions

How many stars are in the universe? Astronomers don't know for certain because they don't know exactly how big the universe is. They estimate that there are 100 billion stars in the Milky Way galaxy alone. It's possible that there are 10 billion galaxies in the universe. If each has 100 billion stars, the number of stars in the universe would be...astronomical!

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What is the Local Group?

THE UNIVERSE

1. A cluster of galaxies
2. Constellations closest to Earth
3. Planets closest to Earth

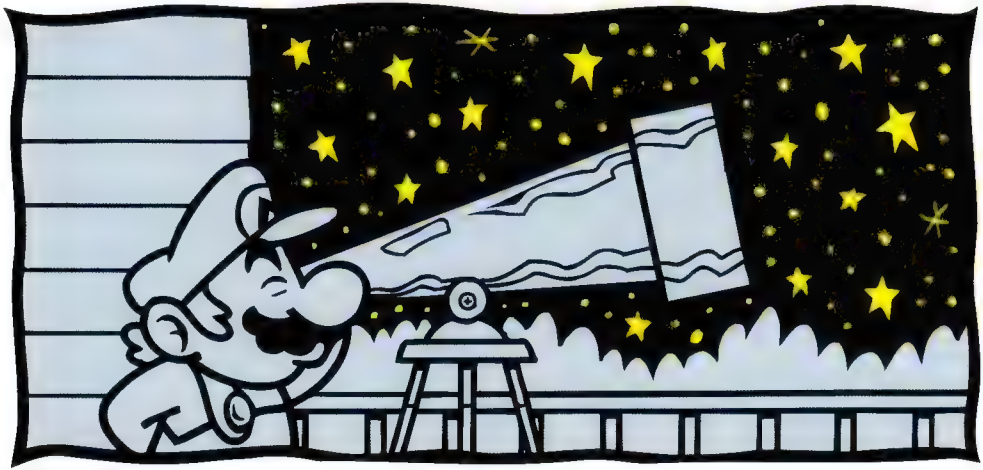

Illustration: Gary Fields

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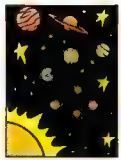
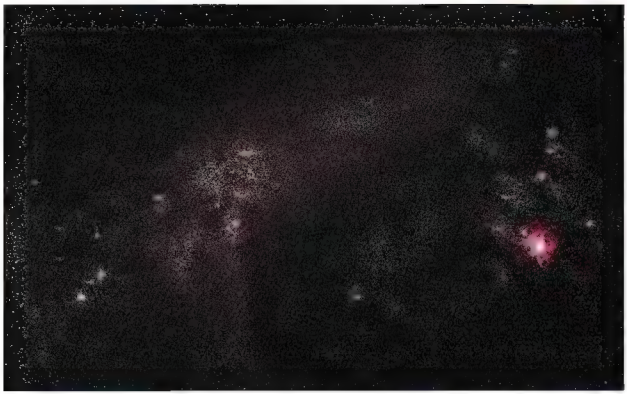
Local Group

The Local Group is the cluster of galaxies to which our galaxy—the Milky Way—belongs.

1 The Local Group is a cluster of galaxies.





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The Magellanic Clouds are two small galaxies near the Milky Way. They can be seen with the naked eye from Earth. They were first noted by Portuguese explorer Ferdinand Magellan in 1519.

A galaxy is a huge mass of stars, gas, dust, planets and other celestial objects. The galaxy that contains our solar system is called the Milky Way. The Milky Way is one of 30 or 40 galaxies in a cluster known as the Local Group.

Local Color

So far, astronomers have identified and named about 24 separate galaxies in the Local Group, and they know more are out there. The Milky Way is the second-largest galaxy in the Local Group. The largest is the galaxy Andromeda. The third largest is Triangulum, also known as the Pinwheel Galaxy.

Beyond our Realm

As enormous as the Local Group is, there are galaxy clusters that astronomers believe are even bigger. The Coma cluster, for example, contains about 1,000 galaxies!

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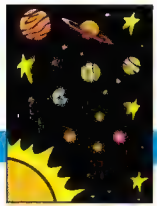
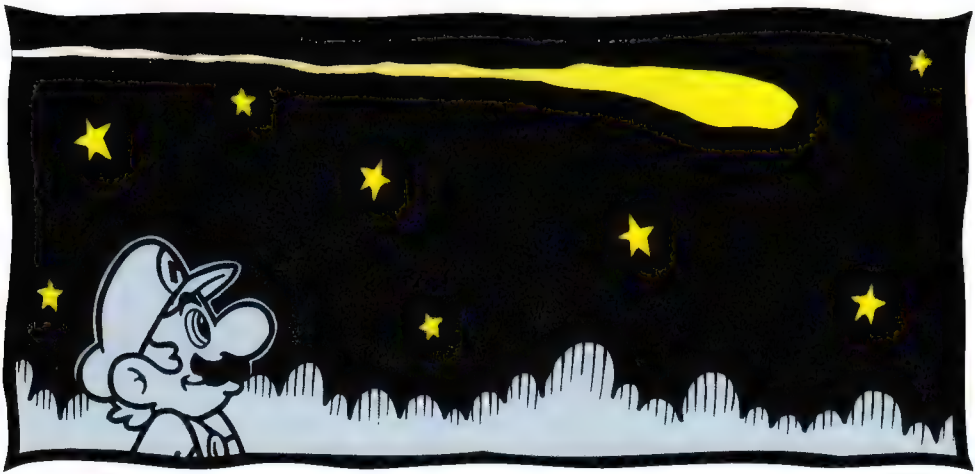
Who discovered the Hale-Bopp comet?



THE UNIVERSE

1. Backyard astronomers
2. Government astrophysicists
3. University professors



Illustration, Gary Fields

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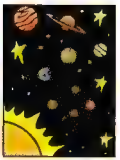
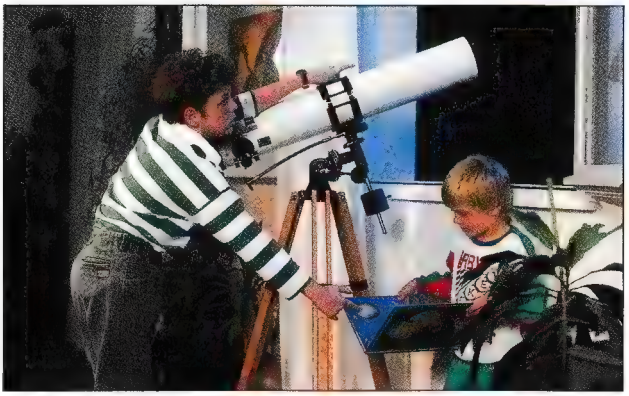
Comets

Astronomers refer to comets as "dirty snowballs." They consist of a solid nucleus followed by a tail of gas and dust. They are rarely observable from Earth.

Backyard astronomers discovered the Hale-Bopp comet.





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Comets are named for the people who discover them. You don't have to be a professional astronomer to find a new comet, you just have to keep watching the skies!

Many astronomers, both amateur and professional, are constantly on the lookout for comets. Because a comet may be visible from Earth only once in a thousand years, they don't know when an uncharted one might make an appearance.

Two Stargazers

In July 1995, Alan Hale was in his backyard in New Mexico using his telescope to study two known comets. He's a professional astronomer, but he was doing this for fun. Just by chance, he turned his telescope to another part of the sky and spotted a comet he'd never seen. He sent an e-mail query to the Central Bureau for Astronomical Telegrams asking for information on the it. That's when he learned he'd found a totally new comet!

Meanwhile in Arizona, amateur stargazer Thomas Bopp also saw the unidentified comet. Because Hale and Bopp contacted the Central Bureau at about the same time, the comet was named for both of them.

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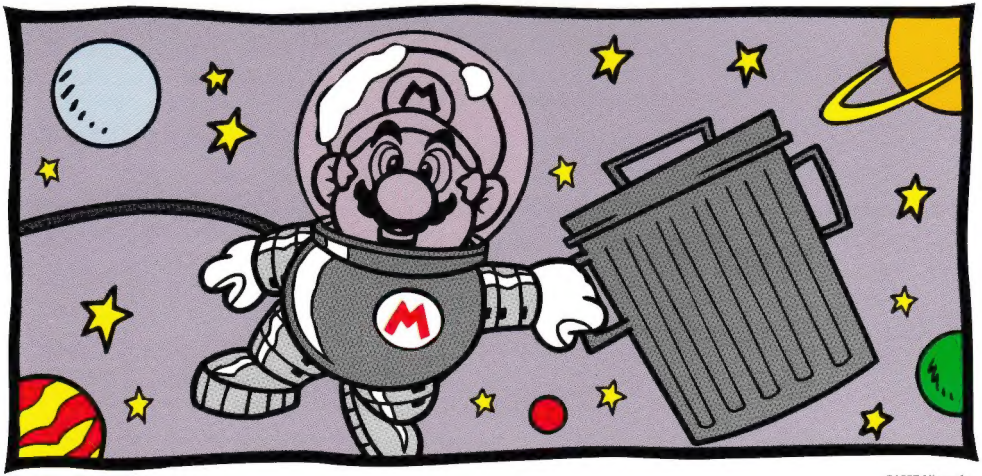
What is “space junk”?

THE UNIVERSE

1. Debris left by spacecraft
2. Poison gas from stars
3. Unidentified planets



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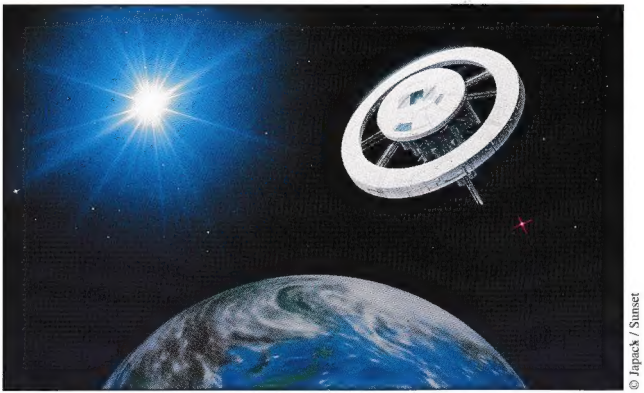
Space Junk

For years, some humans have been dumping their garbage in space! Pieces of equipment and other useless objects from past space missions are still floating around in space.

1 **Space junk is debris left by spacecraft.**



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When satellites are no longer useful they may be abandoned in space. Many years' worth of space junk is now cluttering up the universe!

Instead of rescuing malfunctioning satellites, space agencies sometimes leave them out in space. The same goes for pieces of equipment, tools, and other items that float away from astronauts and their crafts while they're in space. Today, there are more than 30,000 pieces of space trash floating in the universe. They range from entire satellites to paint chips and fragments of metal.

Space Dump

The trouble is, once the debris is lost in space it doesn't disappear. It doesn't decompose and it doesn't disintegrate. It just keeps floating around. So much space junk now presents a hazard for working spacecraft. While it floats, the junk gains speed. Paint chips can zip around at more than 15,000 miles per hour (24,000 km/h)! One of those tiny chips completely smashed the windshield of a *Challenger* spacecraft!

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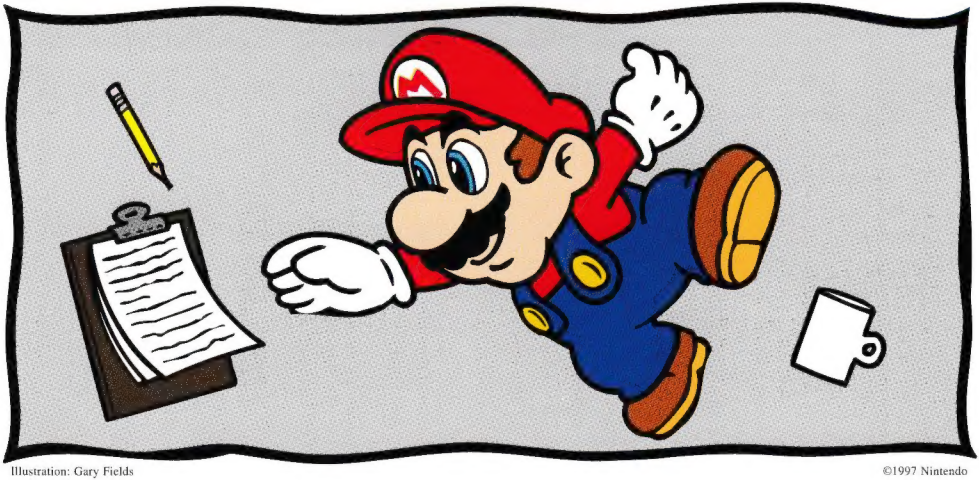
Where do astronauts train to prepare for weightlessness?

THE UNIVERSE

1 Deserts

2 Mountains

3 Underwater



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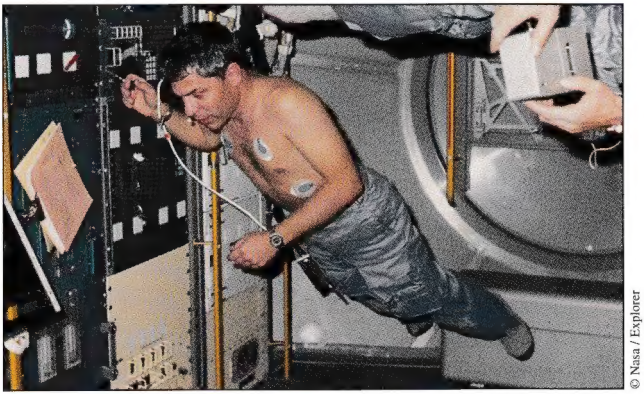
Weightlessness

One of the most difficult things about traveling into space is becoming accustomed to weightlessness or zero gravity. So, before they blast off, astronauts train to prepare for it.

3 Astronauts train underwater to prepare for weightlessness.



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It's hard to work when your feet don't touch the ground! Weightlessness is an odd and exciting sensation, but it also puts strain on an astronaut's heart and bones.

Part of an astronaut's training is done in a Neutral Buoyancy Simulator, or NBS. The NBS is basically a very deep water tank. Astronauts, in full gear, use the underwater environment to simulate the zero gravity conditions of outer space. In the NBS, an astronaut performs many of the tasks that must be performed in space, such as equipment operation and repairs.

Floating Away

Though it looks like fun to float around a spacecraft in zero gravity, it's not much of a help if you have work to do. When there's no gravity a person can't exert any force. A simple act such as turning a screw with a screwdriver becomes impossible. This is why spacecraft are equipped with hand and foot holds that astronauts use to steady themselves when they're working.

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